Publication 64
Revised December 1989

# 1990-1991

# INSECT AND DISEASE CONTROL IN THE HOME GARDEN

Ontario

Ministry of
Agriculture
and Food

David Ramsay, Minister

INFORMATION

VEGETABLES

ORNAMENTALS

PRODUCTS

ILLUSTRATIONS

## ACKNOWLEDGMENTS

The recommendations contained in this publication have been prepared in consultation with:

— Ontario Crop Protection Committee

and personnel of:

- — Plant Industry Branch, Ontario Ministry of Agriculture and Food
- — Ontario Agricultural College, University of Guelph
- — Agriculture Canada
- — Ontario Ministry of the Environment
- — Royal Botanical Gardens
- — Ontario Ministry of Natural Resources
- — Ontario Ministry of Labour
- — Health and Welfare Canada
- — Horticultural Research Institute of Ontario

Pesticide products listed in this publication have been reviewed by the Ontario Pesticides Advisory Committee and have been classified under the Pesticides Act.

## PESTICIDE POISONING — EMERGENCY PROCEDURES

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation or contact with skin or eyes, the label on the pesticide container should be read and the suggested first-aid treatment carried out.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water. If a pesticide has come in contact with the eyes, rinse them with plenty of water for 15 minutes.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN AT HOME, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM/HER TO THE NEAREST HOSPITAL, TAKING THE LABELLED PESTICIDE CONTAINER WITH YOU.

### First-Aid Information

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation of first-aid information and advice. They can be contacted in the following manner:

Between the hours of 8:00 a.m. and 5:00 p.m.
Monday to Friday, telephone (416) 965-3610

During weekends, public holidays and non-office hours
telephone (416) 965-2111 and ask for the "on-call"
physician.

*Persons seeking answers to questions on pesticides should call, toll-free:

1-800-267-6315

The National Pesticides Call Line of the Pesticides Directorate of Agriculture Canada.

Information officers will answer questions regarding the registration process, safety precautions, label instructions, and issues surrounding pesticide use. Pesticides can include such products as insecticides, herbicides, fungicides, rodenticides, wood preservatives and household disinfectants.

The pesticides listed in this publication are registered by Agriculture Canada, Ottawa. A pesticide product should not be used on any plants unless they are mentioned on the registered product label.

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# INTRODUCTION

This publication provides the home gardener with pest control information necessary to grow productive vegetables and fruit, as well as attractive trees, shrubs and flowers.

Emphasis is placed on good cultural practices as a way of controlling pests. The use of pesticides is recommended only when and where actually needed. To control pests with a minimum amount of pesticides requires observation and some understanding of pest problems.

Only those pesticides with a DOMESTIC label are recommended. Products having a commercial, agricultural or restricted label should not be used by the home gardener. As pesticide regulations may change, the use of this publication is intended only for the two-year period of 1990-91.

# GENERAL INFORMATION

## Chemical and Cultural Treatments

Control of pests in the home garden is more than a matter of applying chemicals. Cultural practices such as time of planting, crop rotation, plant density and clean-up of affected plants and refuse are important considerations. In this publication control by means of pesticides as well as the cultural treatments are discussed.

## Diagnosing Plant Problems

To diagnose a plant problem it is important to take into account all biotic and abiotic factors which may be affecting plant growth. It is important to know normal growth characteristics and conditions required by a particular plant. Take note of any abnormal growth or symptoms expressed by a plant, the distribution of symptoms on an affected plant, the distribution of affected plants in the area, and plant species affected. Inspect the affected plant(s) closely for webbing, cast skins, excrement, and other signs of pests, as well as for their actual presence. Also check for fungal mycelial growth and spore-producing structures, or bacterial ooze which might indicate the presence of infectious disease. Background information, such as pesticide use in the area, fertilizer application, watering and other cultural practices, and weather conditions in relation to symptom development, should be taken into consideration for a complete diagnosis.

Once you have gathered all pertinent information, make your diagnosis. An accurate and rapid diagnosis is very important in order that correct controls can be implemented as soon as possible, thereby minimizing aesthetic and yield losses. If you are unsure of your diagnosis, or of the correct control measures, to employ, contact a horticulturist, local OMAF office, or the Pest Diagnostic and Advisory Clinic, for additional information.

## Our Environment

The "mini-environment" of the garden is important and should be protected. In addition to chemical means of control, this publication contains recommended cultural methods of reducing disease infections and injury by insects on fruits, vegetables and other plants. Follow these cultural methods of pest control whenever possible, keeping in mind that some use of pesticides may be necessary for satisfactory yield and quality.

Spray or dust with insecticides only when really necessary, as damage to beneficial insects is caused by indiscriminate applications. Do not apply insecticides to fruit and vegetable crops while they are in bloom. The Bees Act makes it an offence to do so. Honeybees are important for the pollination of fruit trees, raspberries, strawberries, cucumbers, melons, squash, pumpkins, peas and beans. Because carbaryl, diazinon, dimethoate, malathion and phosmet are very poisonous to bees, these insecticides are not to be used on any plants while in bloom. When insecticide treatment is necessary on an ornamental plant which flowers over a long period, spray or dust in the late evening when the bees are not visiting the flowers. *Bacillus thuringiensis* is harmless to bees, while rotenone and many fungicides have low toxicity.

Avoid the practice of spraying all the plants in the garden just because one particular kind of plant requires a spray.

Fungicides are generally of less potential harm to beneficial insects, pets, and people than insecticides.

Many pesticides are toxic to fish, so care must be exercised to prevent them from getting into streams or ponds. After spraying, rinse the sprayer thoroughly with water and apply rinse water to the treated area. Triple rinse pesticide containers before disposal in garbage.

## Natural Control of Insects

Many insect pests have natural enemies which provide some control. The control provided, however, is often insufficient to be entirely suitable to the gardener or farmer.

Predacious insects (such as lady beetles and their larvae, syrphid flies and lacewing larvae, assassin bugs and many beetles) prey upon other insects — especially aphids. Parasites such as the ichneumon wasp and tachinid flies lay their eggs on, or in, caterpillars which are then eaten by the larvae, or the young of the fly. Spiders, birds, frogs, snakes and mice also help to reduce the insect population, but may catch beneficial as well as harmful insects.

In order to conserve and promote the beneficial predatory and parasitic insects and other organisms in your garden, observe the following guidelines:

1. Plant a variety of flowering plants which provide pollen and nectar food sources for many adult insects such as parasitic wasps and flies.
2. Use pesticides only when necessary, confining the application to only the plants affected by the pest.
3. Avoid pesticide drift to neighboring plants which may harbor beneficial insects.

4. Hand pick larger insects such as tomato hornworms or Colorado potato beetles, and wash off aphids or mites with a strong jet of water whenever possible.
5. Check to see whether beneficial insects are already providing control before using pesticides.
6. Mulches between the rows of plants provide a natural refuge for predators such as ground beetles, but this may also encourage slugs and sowbugs.

Collecting and introducing native predators such as ladybird beetles may help control outbreaks of relatively non-mobile insects (such as young aphids or whiteflies) when introduced **before** damaging levels of the pest are reached. However, the introduction of ladybird beetles *(Hippodamia convergens)* imported from the U.S.A. is not an economical way to control pests in the garden. These beetles are introduced after having been collected while overwintering in the mountains of California. Upon release here, they fly away, utilizing stored fat before settling down to feed again. Thus, few, if any, will remain in your garden to provide the desired control. On the other hand, beneficial parasites and predators that are available in Ontario and best suited for home greenhouse use, are available for the following pests:

| **Target pest** | **Predator or Parasite** |
|---|---|
| 1. *Tetranychus urticae*<br>2-spotted spider mite | 1. *Phytoseiulus persimilis*<br>(a red predatory mite) |
| 2. *Trialeurodes vaporariorum*<br>greenhouse whitefly | 2. *Encarsia formosa*<br>(a minute parasitic wasp) |
| 3. Aphids | 3. *Aphidoletes aphidimyza*<br>(a predatory midge) |
| 4. Thrips | 4. *Amblyseius cucumeris* |

Routine introductions are necessary for success. These beneficial insects or predators are available from:

Safer Ltd.
465 Milner Ave
Scarborough, Ontario
M1B 2K4
(416) 291-8150

Ritchers
Goodwood, Ontario
L0C 1A0
(416) 640-6677

Better Yield Insects
Box 3451
Tecumseh Station
Windsor, Ontario
N8N 3C4
(519) 727-6108

Canadian Hydrogardens
411 Book Road West
Ancaster, Ontario
L9G 3L1
(416) 648-1801

Climate has an effect on insect population: in colder areas of the province, fewer generations of insects are produced than in the warmer areas. Late spring frosts and cold, wet springs are harmful to newly hatched larvae. Heavy rainfall washes small insects such as mites and aphids from plants.

It is important to know that *some beneficial insects are killed by smaller doses of insecticides than are required to kill harmful insects. For this reason, insecticides should only be applied when insects cause actual damage, or did so in the previous year, and preventive treatment is the only means of control. This publication specifically states when preventive treatment for certain insects may be needed.*

## Companion Planting

Companion planting, or the interplanting of crops with other plants so as to repel or prevent pest outbreaks, has been advocated by some as an effective technique of pest control.

In three years of detailed experimentation by staff of the Pest Diagnostic and Advisory Clinic, University of Guelph, this technique was evaluated for the control of pests of cabbage, potato, and roses. Plants described in popular literature as having insect repellent characteristics were planted around and within replicated plots of these crops and maintained using "organic" methods. Companion plants used were basil, bean, catnip, celery, chives, dill, flax, garlic, geranium, hyssop, horseradish, French and African marigold, nasturtium, parsley, peppermint, sage, tansy, thyme, tomato, and wormwood.

Most of the pests encountered were not significantly affected by any of the companion plants. Companion plants were not a reliable method of pest control for the following reasons:

- competition with the crop resulted in reduced yield;
- control of insect pests was only limited to one or two of several pests found on the crops;
- control was inadequate to prevent significant losses in yield and quality.

The only combination which consistently showed some promise was the interplanting of beans and potatoes for reducing injury from Colorado potato beetles and potato leafhoppers.

Should companion planting be considered as a method of pest control in the garden, some suggestions for improving the likelihood of success are as follows:

- avoid close planting of highly competitive, densely foliated plants near the crop. For example, avoid planting African marigold, catnip, celery, tansy, tomato, and wormwood as companions unless sufficient space is allowed;
- avoid using plants such as wormwood which produce chemical substances which reduce the growth of nearby plants;
- avoid companion plants which could serve as alternate hosts for pests or diseases of the crop. For example, flea beetles will attack nasturtium as well as cabbage;
- choose plants of aesthetic or culinary importance which could also provide enjoyment or food;
- always leave some of the crop without companion plants to objectively assess whether or not any benefit is resulting from this technique.

## Sanitation Instead of Crop Rotation for Insect and Disease Control

A good commercial farmer can reduce the damage to his crops from insects and diseases by crop rotation. The principle of this method is that many insects or their eggs, as well as disease-causing fungi, overwinter in plant debris and weeds (or in the soil) and will be present in abundance to attack next year's crop if it is the same as in the previous year. However, if next year's crop is a different one on which these insects or fungi cannot live, then the potential damage will be reduced. (Some fungi can survive in the soil for several years, requiring crop rotation of several years to avoid repeat disease problems.)

In a small garden this does not work in quite the same way. Most insects can easily fly or crawl throughout the garden to reach their preferred plants, and diseased plant refuse, such as dead tomato leaves, will either be blown by the wind over the garden or along the fence, or be moved inadvertently from one place to another by a person. Hence, crop rotation in the home garden does not provide very effective protection against insects and diseases. But the gardener has an advantage over the farmer in that he can gather all plant refuse (including large weeds) and destroy it, which the farmer with large fields cannot do. *This should be done throughout the summer and finally when cleaning-up in early fall. All this refuse should be disposed with the garbage, burned or buried at least 60 cm deep.* Some insects overwinter under boards, bricks, stones, etc., hence, these should be removed and stored without being in contact with the soil. Throughout the recommendations in this publication you are reminded of these sanitary measures, which often are the only way the gardener can reduce his pest problem.

## Composting

Compost adds valuable organic matter to the soil and returns plant nutrients to the soil. However, the compost pile in the home garden may be too small to generate enough heat to kill insect pests, weed seeds, roots of perennial weeds and disease-causing fungi, especially during cold autumn weather. Shredding the material added to the pile, keeping it moist in dry weather and turning the pile will increase the rate of decomposition and help to develop the high temperatures needed to kill weed seeds and disease-causing organisms.

If diseased plants cannot be composted in a hot compost pile, it may be best to send them to the dump with the garbage. See page 75 for OMAF Factsheets on composting.

## What are Pesticides?

Pesticide chemicals include: insecticides that control insects; fungicides that control diseases caused by fungi; herbicides or weed-killer compounds that control weeds; and others.

## Systemic Insecticides and Fungicides

Dimethoate and oxydemeton-methyl are examples of insecticides having a systemic action. This means that they are absorbed by the foliage on which they are sprayed or by the roots, in the case of soil applications, and are moved with the sap inside the plant. Most of the systemics are moved upward in the plant, not downward, with water absorbed by the root system. Insects which suck sap, such as aphids, leafhoppers and leafminers are controlled, but beetles, caterpillars and wood borers are not.

Benomyl and triforine are examples of systemic fungicides. They are absorbed by foliage and are carried toward the margins and tips of leaves. The systemic action of these pesticides (insecticides and fungicides) is helpful because once absorbed, systemics counteract uneven spraying, and washing-off by rain of the pesticide. The systemic insecticides may at the same time act as stomach poisons and contact sprays; the systemic fungicides may kill spores of a fungus that land on a coating of the chemical on a leaf. The systemics do not give permanent control because they gradually breakdown within the plant and are diluted by being distributed within the plant, or by new plant growth.

## Are Pesticides Needed?

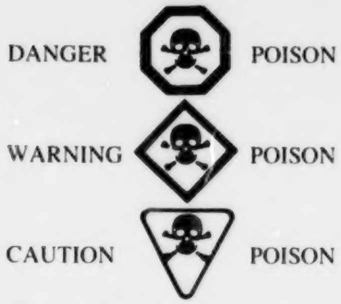
Pesticides are often required to ensure high yields of high quality crops. Nearly all fruit and vegetable crops attract pests which will cause damage if not controlled. Often, the most serious pests are those not native to Canada, but which have been inadvertently introduced. Here they multiply freely in the absence of the natural enemies (predatory and parasitic insects) of their original habitat, or perhaps because the climate is more favorable for a rapid increase during the growing season. In the absence of natural enemies, or because the enemies cannot increase rapidly enough to provide good control of a sudden outbreak, pesticides are often required.

It is normal for garden plants to suffer some damage from pests. Healthy plants can withstand pest attack better than those growing under difficult conditions. You must decide how much pest damage you can tolerate before control is necessary. A few blemishes on produce, or spots on leaves are not usually worth the cost and time spent in control efforts. To be economical, the cost of control should be less than or equal to the amount of crop loss sustained. Ask yourself the question, how much damage can I realistically live with before resorting to the use of pesticides?

## Safe Use of Pesticides

Only those pesticides (insecticides, fungicides, etc.) which include the word DOMESTIC on the label may be legally sold to, and used by, the home gardener. The label on such products is written specifically for use in home gardens. Very toxic (poisonous) chemicals may not be sold under a DOMESTIC label. The toxicity of each product depends on the active ingredient and its concentration, as well as on the diluents. All liquid pesticides containing more than 10% petroleum distillates must carry the Danger-Poison symbol regardless of the toxicity of the active ingredient. A poison symbol is not required for products of low toxicity.

Poison symbols on the label indicate the toxicity in diminishing order:



The label of each product is based on extensive research on its hazards to humans, domestic animals and wildlife (birds, fish, bees, etc.). The Pest Control Products Act stipulates that the complete text on the label be approved and registered by Agriculture Canada, Ottawa, before it is printed. This ensures that all pesticides available in Canada have been approved and registered before going on sale.

Pesticides can be used safely if all of the instructions on the label are followed. These instructions include precautions, first-aid (where applicable), disposal of empty containers, rate of application and the plants on which the product may be used. Some products have part of the directions on an attached pamphlet or on the carton in which the bottle is packed. Keep pamphlet and/or carton with the product.

Several manufacturers may sell the same pesticide, but their labels are not necessarily identical as far as the recommended plants and crops are concerned. Before the product is purchased, the prospective buyer should check the label to determine whether the intended use is mentioned. It is only safe to apply a chemical on a fruit or vegetable if the label gives directions for that specific crop. *It is advisable to take this publication to the store when buying a pesticide product for garden use.*

The "no-spray" interval before the harvest of edible crops is stated on the label. The pesticide must not be used closer to harvest than the interval indicated, so that possible harmful residues on the fruit or vegetable are avoided. The interval before harvest is usually different for each crop and each pesticide.

## Basic Rules for Safe Use of Pesticides

- Buy and use only a pesticide with a DOMESTIC label.
- Do not use a product marked AGRICULTURAL, COMMERCIAL, INDUSTRIAL, or RESTRICTED.
- Store pesticides in a locked place, out of the reach of children and pets.
- Do not leave pesticide containers unguarded while spraying.
- Never transfer the contents to an unlabelled container.
- Pay attention to any symbols indicating "poison," "flammable," or "explosive."
- Apply pesticides only when actually needed.
- Apply only on fruits, vegetables and other plants listed on the label.
- Observe the no-spray interval before harvest for each edible crop.
- Do not use higher rates than recommended, and always measure the quantity — do not guess.
- Do not use milk or soft-drink bottles and kitchen utensils for measuring.
- Discard empty pesticide containers with the garbage.
- Wash hands and face after applying pesticides and before eating or smoking.
- Do not leave pesticide residues in the sprayer; wash them out after use.
- Read the entire label and follow the directions carefully.

## Pesticide Formulations

Pesticides are available to the home gardener in the formulations listed below. (For available products, see pages 77-81).

| | |
|---|---|
| •EC | Liquid emulsifiable concentrates for spraying: mix with water. |
| •L | Liquid suspensions for spraying: mix with water. |
| •WP | Wettable powders for spraying: mix with water and shake. |
| •D | Dusts: ready to use in dry form. |
| •G | Granulars: ready to use in dry form; mostly for soil application. |
| • | Pressurized sprays: ready to use as spray. |
| • | Baits: ready to use in dry form. |

Chemicals applied as a spray are more effective than those applied as a dust, and, once they have dried thoroughly, are less likely to be washed off by rain.

Pressurized sprays (aerosols) are convenient for spraying individual plants. They may be uneconomical for general garden use and are generally less effective than conventional sprays.

## Multipurpose Mixtures

Multipurpose pesticide mixtures contain several ingredients (usually one or more insecticides and a fungicide). Wherever possible, use individual fungicides or insecticides rather than a multipurpose mixture. This reduces the unnecessary application of an insecticide, if a fungicide is all that is required. Most insecticides and fungicides can be mixed in the sprayer if necesary. (See Rate and Method of Application, page 6.)

## Names of Products and Chemicals

Each chemical registered for controlling pests has a **common chemical** name which must be stated after the **"guarantee"** on the front panel of the label. Manufacturers often give products their own brand name; however, because of the many pesticide products on the market, all recommendations in this publication are given by common chemical names.

The lists of available insecticides, fungicides and multipurpose mixtures on pages 77 to 81 relate the common chemical names to the corresponding products sold in Ontario. These lists indicate whether a product is permitted for use on fruit trees, small fruits, grapes, vegetables, ornamentals (flowers, shrubs, trees) or lawns.

## Time of Application

Time of application stated throughout this publication applies to the part of Ontario south of the line from Ottawa to Sudbury. Even in that area, the emergence of insects varies according to the average temperature and growth conditions. These differences are the greatest in the spring and gradually disappear by midsummer. In addition, weather conditions in the spring vary from year to year and some judgment is needed regarding the timing of treatments. The same principle applies to the northern parts of Ontario where spring is late.

## Rate and Method of Application

The rate of application for spraying pesticides depends on the concentration of active chemical ingredient in the product. Furthermore, different rates of the same product may be needed for the control of various insects or diseases. The scope of this publication does not allow for inclusion of recommendations of rates; therefore, **the label of each product should be consulted before mixing a pesticide with water.**

The rates for applying pesticides as a spray are expressed by volume of water. When applying the spray, the foliage and fruit should be covered from all sides until they drip. Do not apply sprays when temperatures are extremely high (27°C or above). If it is necessary to spray during hot weather, do so in the morning or in the evening. Plant injury is apt to occur when sprays are applied during these high temperatures or if the air is very humid, causing slow drying of the spray.

The rates for chemicals to be applied on the lawn or soil are based on the surface area. The volume of water is not important as long as it is sufficient to cover the area. It depends primarily on the type of sprayer because coarse sprays apply more liquid than fine sprays.

Spray mixtures using very hard water have a shorter period of effectiveness than sprays made with medium-hard or soft water. If your tap water is very hard, use rain water (if possible).

Dusts are ready to use and should be applied in such a manner that all parts of the plant are covered by a thin layer of dust. It is essential that dusting be done when the air is calm. This is usually more likely to be the case in the early morning or in the evening.

**Use the correct rate of pesticide as specified on the label.** Rates higher that those on the label may cause injury to plants, kill beneficial insects and leave harmful residues on edible crops. Rates lower than recommended may result in unsatisfactory pest control.

Most home garden insecticides and fungicides, except lime sulfur, may be mixed together in a pail or sprayer. Always mix a wettable powder with water first before adding a liquid product.

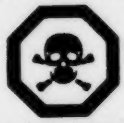
**Sample Label**

**XYZ PRODUCT**
**INSECTICIDE**

*Liquid Emulsifiable Concentrate*

**DOMESTIC**
**GUARANTEE: (common chemical name) %**
**REG. No. 00000**
**PEST CONTROL PRODUCTS ACT**
**(or P.C.P. Act)**

**DANGER**



**POISON**

**Read the label before using**

Net Contents:....millilitres

**John Doe Co. Ltd., Ontarioville**

DIRECTIONS FOR USE on apple, pear, cabbage, cucumber, tomato, birch, rose and annual flowers (except petunia).

To control aphids, caterpillars, flea beetles, leafhoppers, cucumber beetles and tomato hornworms, apply when many insects are noticed and repeat as necessary. For codling moth on apple and pear, apply in late June and repeat every 7 days until mid-August. For birch leafminer, apply when young leaves unfold and repeat in early July.

Mix 15 mL (1 tablespoonful) in 5 L of water and spray all foliage and fruit thoroughly. Do not apply later than 7 days before harvest on apple and pear, and not later than 3 days before harvest on cabbage, cucumber and tomato. Do not use on any other edible crops.

PRECAUTION: Keep out of reach of children. Hazardous if swallowed, inhaled or absorbed through the skin. Avoid breathing spray mist and contact with skin and eyes. Wash after use and before eating and smoking. Avoid contamination of food, feed and water; this product is poisonous to fish. To avoid killing bees, spray flowers only in late evening when bees are in their hives. Do not spray fruit trees while in bloom.

FIRST-AID: If swallowed, DO NOT induce vomiting but rush patient to nearest hospital taking this labelled container with you. If in eyes, flush with plenty of water for 15 minutes and get medical attention. If on skin, wash with soap and water. This product contains petroleum distillates. The chemical may cause cholinesterase inhibition; atrophine is antidotal.

Dispose of empty container with regular garbage; do not reuse.

## Application Equipment

Good equipment is essential for the proper application of pesticides.

The following types of sprayers are available:

- Portable tank sprayers with 4 to 12 L capacity are suitable for medium and large gardens. They operate by pumping air into the tank before spraying is started.
- Bottle-type sprayers with 0.5 to 1 L capacity are practical for small gardens and for spraying a few plants. They operate by continuous pumping with the squeeze-type handle during spraying.
- Hose-end sprayers are operated by the water pressure in the garden hose. The highly concentrated spray mixture is siphoned from the jar into the water stream from the hose. Hose-end sprayers do not work well for wettable powders at rates of more than 100 mL (7 level tablespoonsful) per 5 L of water or for any pesticides if the water pressure is low. A potential problem with this type of sprayer concerns the valve in the head. If this becomes defective, the concentration of the spray may be higher or lower than intended. This may cause damage to plants and/or harmful residues on edible crops if too high, or lack of control if too dilute. Test the accuracy of the sprayer at least once a year by spraying a certain volume of water into a pail and comparing it with the measurement on the jar.

It is recommended that you do not use the same sprayer which was used for weed killers to apply insecticides and fungicides because it is very difficult to adequately clean weed killers from a sprayer. Doing so may cause severe injury to plants. To avoid this, **use a separate sprayer for weed killers**.

If dust is to be used, a proper duster is required. Excessive quantities of dust may damage the plants and leave harmful residues on fruits and vegetables. Some dusts are sold in plastic squeeze-duster containers which work well. Shaker-cans with holes in the lid apply too much dust on the upperside of the foliage and none on the underside; however, they are suitable for applying insecticides on the soil. Burlap bags are unsuitable as they create an inhalation hazard and apply far too much pesticide.

### Responsibility of the User

*As a result of research and legislation, the pesticide label, as prepared by the manufacturer, is a reliable document prescribing the manner by which chemical pesticides can be used safely. Harmful effects to man and his environment are created by careless use of the pesticide. It is the responsibility of the user to handle, store and apply pesticides correctly and safely.*

## Use and Maintenance of Equipment

The purpose of dusters and sprayers is to distribute the pesticide on the affected plants. Thorough and even coverage with pesticides is essential; poor control is often the result of improper or poor coverage.

The kind of pesticide application equipment required by the home gardener depends on the type and size of the garden. For a few low-growing vegetables and ornamentals, simple dusters or dusts in shaker packages are satisfactory. For fruit trees and large plantings, a compressed air or knapsack sprayer will be required. The rates applied with these sprayers can be closely controlled. Their range can be extended to cover tall trees by adding sections to the sprayer wand or by using ladders. Trees over 7.5 m will usually require a high-pressure power sprayer for thorough coverage. Since power equipment is expensive, it is usually more economical to hire a commercial pest control firm.

Garden hose sprayer attachments are not recommended because the amounts they apply are variable and difficult to regulate. If there is no other alternative, see page 81 for details on calibrating a hose-end sprayer.

Do not use garden sprayers in the house. If pesticides are to be used indoors, apply them with a small hand sprayer, a paint brush, or an aerosol can.

It is best to have one sprayer for herbicides and another for insecticides and fungicides, as herbicide residues can damage desirable plants. If this is not possible and only one sprayer is available, clean the hose and tank very carefully to make sure that all traces of herbicide are removed. After rinsing, add 1 mL of household ammonia or baking soda per litre of detergent solution, and let this mixture stand overnight in both the tank and hose. The next day, empty the sprayer by spraying the solution out through the nozzle, and rinse the tank with clean water.

If sprayers are properly maintained, they can give many years of service. Some pesticides are corrosive to metal parts, so it is important to rinse and wash out the tank with detergent or soap solution after each use. Leave the tank uncapped and upended during storage to allow it to dry without rusting.

Worn shut-off valves and leaky hoses or joints should be replaced immediately. Faulty sprayers increase the hazard to the applicator and give poor results.

## Sprayer Calibration*

**Reasons for Calibrating a Sprayer:**

Pesticides are recommended at specified amounts per area or per volume (e.g., 10 g/100 $m^2$, 10 mL/100 $m^2$, 5 mL/L). Calibrating pesticide application equipment is the only way to know exactly how much pesticide is being applied. Pesticides applied at the recommended rate will take a certain number of days to breakdown into harmless residues. The number of days required between last application and harvest provide reasonable assurance that the food is safe for consumption. If an overdose is applied, the waiting period is prolonged, although not necessarily in proportion to the amount of the overdose. Pesticides can also damage or kill plants if applied in excess of the recommended rate.

Applying less than the recommended rate, or at intervals other than those on the label, may result in unsatisfactory control.

Treatment times and intervals are usually based on the life cycle of a pest, or on the residual activity of the pesticide.

**How to Calibrate a Hose-End Sprayer:**
Hose-end sprayers are not recommended for the application of pesticides because most do not give an accurate dosage and few can be used to apply wettable powders. In using a hose-end sprayer, follow these steps to improve its effectiveness:

- Before connecting the hose-end sprayer be sure it is in good working order and the siphoning tube, nozzle and filter screens are clean.
- To help maintain a more constant water pressure while spraying, avoid running the water from other taps on the premises.
- Open the tap fully while spraying with a hose-end sprayer.
- After use, flush both the sprayer and the garden hose with water.

If the sprayer has an instruction sheet on calibration, use those instructions, otherwise follow these steps:

A. *Spraying an Area on the Ground*
Do a test spray first, using water only to determine the correct application speed, as follows:

1. Connect the garden hose to the water tap and hose-end sprayer.
2. Adjust the sprayer nozzle to the desired setting (narrow stream, fan shaped, or mist).
3. Fill the hose-end sprayer bottle with water (ink or food color may be added to make it easier to see the amount of water in the bottle).
4. Mark off a 10 m × 10 m area (= 100 $m^2$) using a measuring tape, stakes, and string.
5. Now turn the tap on fully (remember to do this every time thereafter to keep the calibration valid).
6. Walk back and forth over the marked-off area, spraying until the area is covered. Remember the pace of walking and do it at the same rate thereafter.
7. Turn the water tap off and read the amount of liquid left in the sprayer bottle. The difference between this reading and the full mark is the amount of colored water (pesticide) used.
8. If the pesticide container label indicated to use 10 mL/100 $m^2$, and 10 mL were used, then this was the right amount. If more or less than 10 mL/100 $m^2$ were used, adjust the application rate accordingly by walking faster or slower while spraying.
9. Empty the colored water from the spray bottle and refill it with the required amount of pesticide and water to treat the infested area. Turn the water tap on fully and spray the infested area. Thoroughly rinse the sprayer and sprayer hose with water before storing it.

B. *Spraying Trees and Shrubs*
Do a test spray first, using water only to determine the concentration of pesticide you will have to use, as follows:

Fill the sprayer bottle according to the manufacturer's instructions. Where the instructions state to use a pesticide concentrate, replace that amount with colored water. Measure all liquids that go into the sprayer bottle and calculate the percentage of colored water in the total volume of liquids in the sprayer bottle.

Connect the hose-end sprayer, with the spray deflector removed (if possible), to a garden hose. Spray into a pail marked at 1 L intervals and fill the pail to the 2 L mark. Turn off the water.

Measure the amount of colored water (pesticide) left in the sprayer bottle and divide by 2 to determine the amount used per litre of spray in the pail. Multiply this amount by the percentage of colored water in the bottle. This is how much colored water (pesticide) was used in 1 L of spray. Compare this with the recommended dosage of pesticide on the label. If more pesticide was used than recommended, dilute the mixture in the sprayer bottle. If less pesticide was used than recommended, increase the concentration of pesticide in the sprayer bottle.

**How to Calibrate a Pressure Sprayer:**
When filling the sprayer always use a funnel with a very fine screen to filter both the pesticide and the water. This prevents debris from getting into the sprayer and clogging the nozzle.

Do a test spray first, using water only, to determine the correct pressure and application speed, as follows:

1. Mark off a 10 m × 10 m (= 100 $m^2$) area with a measuring tape, pegs, and string.
2. Measure 4 L of water into the sprayer (1 Imperial gallon sprayer holds 4.5 L, 1 American gallon holds 3.8 L).
3. Pump air into the sprayer. (The higher the air pressure inside the tank, the faster the spray will be discharged.)
4. Adjust the nozzle to desired pattern. (For weeds, a nozzle with a flat spray pattern is used. For insects and diseases, use a nozzle that delivers a hollow cone spray pattern.)
5. Use high pressure to spray for insects and diseases, low pressure for weeds.
6. Spray the measured area by walking over it and moving the wand slowly from side to side about 30 cm above ground level.
7. When the area is sprayed, release the pressure by slowly unscrewing the sprayer lid. Let's assume that all the water was just used up. Now it is known that, if that pressure and walking pace are maintained, it takes 4 L to spray 100 $m^2$.
8. If the label states to use 5 mL of pesticides/L of water, and to use 4 L of mixed spray/100 $m^2$, then add 20 mL of pesticide to the 4 L of water and spray it on 100 $m^2$.
9. If an upright plant, shrub, or tree is to be sprayed, spray it with enough water to wet the foliage to determine how much water is required. Then add the proper amount of pesticide. For example, it was determined that it takes 3 L to spray the tree. The label says to use 10 mL/L of water. Mix 30 mL (3 L × 10 mL/L) of pesticide in 3 L of water.
10. When the label specifies to the point of runoff, apply the spray until it drips off the foliage and runs down the branches and stem. This method is used only with ornamentals, not food plants.

11. Thoroughly rinse the sprayer before storing it upside down and open.

**How to Calibrate Application of Granular of Dust Formulations:**
Granular and dust formulations of pesticides do not require mixing and often come in convenient ready-to-use packages. Rates for granular or dust formulations are expressed in several different ways.

A. The label may recommend a pesticide rate based on the length of a row. For example, a label may specify using 40 g of the formulation on a row 10 m long. If the row is 5 m long, apply half that amount of pesticide (in this case 20 g).

B. Recommended rates of granular or dust formulations may be based on a given area. For example, a label may specify using 300 g/100 m². To determine the amount of pesticide that will be required:

(1) Calculate the area to be treated by multiplying the length by the width (e.g., Area = 2 m × 5 m = 10 m²).

(2) **Carefully calculate** the amount of pesticide needed for this area as follows: Recommended rate × Area to be treated

$$\frac{300\ \text{g}}{100\ \text{m}^2} \times 10\ \text{m}^2 = 30\ \text{g}$$

(3) Apply the calculated amount of pesticide evenly over the area.

If a fertilizer type of spreader is used to apply granules on a lawn, first measure the rate of output of the spreader. To do this:

1. Either attach a plastic bag onto the spreader or put a piece of paper or plastic on the ground to catch the granules. This piece should be at least as wide as the spreader and 2 m long. A longer piece of plastic or paper will help to determine the output more accurately.
2. Put a small, evenly distributed amount of the pesticide in the spreader.
3. Next, determine the correct adjustment for the spreader and/or the correct walking speed. Keeping the spreader closed, start walking approximately 3 m in front of the paper or plastic sheet. When reaching the sheet, without changing the pace, open the spreader so that the pesticide drops onto the sheet. Close the spreader after walking 2 m (= 2 large steps).
4. Weigh the amount of pesticide on the paper.
5. Measure the width of the spreader and the length covered to determine the area treated with the chemical (width of spreader × length travelled). For example, if the spreader is 1 m wide and the paper 2 m long, an area of 1 × 2 = 2 m² was treated.
6. Determine the amount (g) applied on 1 m². Divide the amount in step 4 by the area calculated in step 5. For example, if 200 g were applied on 2 m², the spreader was dropping 200 ÷ 2 = 100 g/m².
7. Check the label to see if the correct amount of pesticide was applied. If the label reads: 5 kg/100 m² (5000 g/100 m²) apply 50 g/m² (not 100 g/m²). In the example, too much pesticide is being applied. Adjust spreader to a slower output or increase walking speed to reduce the pesticide rate and redo the test run until the output rate is correct. To ensure an even coverage, go over the lawn twice using half the amount of pesticide each time in a criss-cross pattern. First walk lengthwise up and down the lawn (Figure A), then walk back and forth across the width of the lawn. For the above example, 25 g/m² would be applied each time.

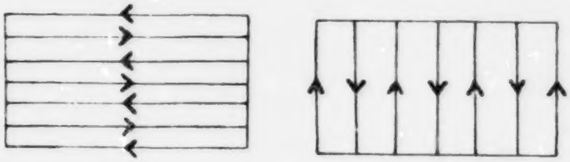


Figure A
*Pattern for pesticide application on a lawn*

8. If the spreader cannot be adjusted, measure the area to be treated, weight out the required amount of chemical and evenly distribute it by hand using rubber gloves. A metric weighing scale and metric measuring spoons are available and should be purchased. See page 95 for Imperial to metric conversions.

**Sprayer calibration section courtesy of the British Columbia Ministry of Agriculture and Food.*

# INSECT AND DISEASE CONTROL ON VEGETABLES

The battle against insects and diseases includes chemical controls as well as cultural methods, such as clean-up of affected plants or crop refuse after harvest, and the proper timing of seeding and planting to avoid insects. These cultural methods are recommended where applicable. However do not depend on the one approach alone.

## Insects

Many insects, such as aphids, caterpillars and beetles can easily be seen on plants, and the gardener can decide when control measures are required based on the number and types of insects, and the amount of injury present. Depending on the insect infestation, weather and rate of plant growth, treatments may have to be repeated. When sprays have dried, they are more resistant to washing off by rain than dusts.

Other insects such as maggots on onions, beans, peas, corn, carrots, radish, rutabagas (turnips), cabbage and related crops, as well as the squash vine borer, are not likely to be seen until damage is done; therefore, these insects require preventive treatment if they are known to be a local problem.

## Diseases

Foliage diseases must be controlled by fungicide applications before infection occurs. Repeated applications may be necessary at 5- to 10-day intervals to cover and protect new growth. The upper and lower leaf surfaces must be covered by the spray or dust for best results. The threat of foliar disease is greater during rainy periods or repeated watering than under dry conditions. The following tables indicate whether certain diseases are a common annual problem or occur only in some years. In the latter case, it is usually impractical to apply preventive sprays before infection takes place. Spraying should then be started when the first disease symptoms are noticed.

## Rate of Application

Read the label on the container for the proper rate of application. Also see the discussion on page 6.

## Recommended Pesticides

The recommended pesticides on the following pages are listed by their common chemical name in alphabetical order, not in order of preference. The common chemical name of the active ingredient(s) of each product appears on the front panel of the label following the "guarantee." The lists of available pesticides on pages 77-81 relate the common chemical names to the corresponding products sold in Ontario. These tables also indicate which products may be applied on vegetables.

Where "insecticidal soap" is recommended, the labelled and registered product should be used — NOT ordinary household soap or detergent as these could damage plants and may not be effective.

## Resistance to benomyl fungicide

By using benomyl exclusively to control a certain disease, the fungus may become resistant to this fungicide with the result that it loses its effectiveness. By alternating between benomyl and another fungicide, the development of resistance can be avoided or delayed.

## No-Spray Interval Before Harvest

The no-spray interval before harvesting vegetables refers to the minimum safe period of time between the last application of a pesticide and the harvest of the crops. Vegetables may not be sprayed or dusted closer to harvest than this interval, in order to avoid harmful residues on the produce. This period varies for each product and each kind of vegetable. Consult the product label for the no-spray interval and follow the directions.

## Mixing Products Together

All of the recommended insecticides and fungicides for use on vegetables in the form of liquids or wettable powders can be mixed together in the sprayer if needed. First add the wettable powder to the water and stir. Then add any liquid product. Never mix different dusts together and do not try to mix a dust with water.

## CULTURAL METHODS TO REDUCE DISEASE

**CLEAN-UP** Burn or discard any diseased plant refuse (foliage, fruit and stems). Composting diseased plant refuse is satisfactory *only* if a high temperature in the compost pile can be reached and maintained for several weeks. This seldom occurs in a small pile. See section on composting on page 4.

**MOISTURE** Foliar blight and leaf spotting organisms require free moisture to cause infection. Adequate spacing of plants and thinning of seedlings allow good air circulation and hence quick drying after rain or watering.

**WATERING** Wet foliage promotes disease infection and development. Watering in the morning is advisable, as the plants will dry quickly. Alternatively, use a soaker hose or trickle irrigation system to apply water without wetting the foliage. Watering plants thoroughly and less frequently is recommended.

**DISEASE-RESISTANT VARIETIES** of many vegetables are available. *This resistance applies only to certain diseases.* Check the description in your seed catalogue or on the package.

**VENTILATION** In a cold frame or greenhouse, good ventilation is an important aid in preventing seedlings from becoming infected with disease. Water plants in the morning and follow with ventilation if weather permits.

**DRAINAGE** Soil saturated with water for several days may cause rotting of roots. Good soil drainage is essential.

**WORKING BETWEEN PLANTS WHEN LEAVES ARE WET** (dew, rain, or watering) promotes spreading of diseases. Hoeing, weeding, harvesting and even walking among plants when foliage is wet should be avoided.

**OVERCROWDING** Thin plants adequately to improve air circulation and reduce disease. This practice also reduces plant competition and promotes plant vigor.

**PLANTING SEED OR TRANSPLANTS TOO DEEP** slows emergence, especially in wet, cool soil, and increases chances of seed rot or damping-off and root rot (see page 12). Plant seed or transplants at the proper depth in a warm, moist, well-prepared seedbed for good emergence and establishment.

**CONTROLLING WEEDS** Some weeds serve as reservoirs for insects and diseases. Weeds compete for nutrients and moisture. Season-long weed control is recommended.

**REMOVE** plants or plant parts which are severely diseased before adjacent plants are also affected. This is especially important with virus diseases, some bacterial diseases, club root, *Verticillium* wilt, etc.

**HOT-WATER TREATED SEED** is available from some seed dealers and will prevent certain diseases from being introduced on seed such as tomato and cole crops.

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **MANY VEGETABLES**<br>*(Figure 1, page 82)* | **Aphids** or plant lice are small, soft-bodied insects which suck the sap from plants. They vary in color from green, red to black, and are usually found in clusters on young shoots. Heavily infested shoots are curled. Aphids leave a sticky deposit known as honeydew on the foliage. This later becomes sooty black. All vegetables are susceptible, but aphids are most common on broad (Windsor) bean, broccoli, Brussels sprouts, cabbage, cauliflower, cucumber, eggplant, melon, pea, pepper, potato, spinach, and rutabaga (swede turnip). Spray or dust when aphids are abundant. *Not all recommended pesticides are registered on all vegetables; apply only on crops listed on the label.* | diazinon<br>dimethoate<br>insecticidal soap<br>malathion<br>pyrethrins |
| | **Bacterial soft rot**, caused by the bacterium *Erwinia carotovora*, attacks many vegetables in the field and storage, including carrots, sweet potato, garlic, cucumber, melon, pepper and tomato. The bacteria enter through wounds causing a rapid, wet rot with an offensive odor. The flesh becomes very soft and pulpy as the cellular tissue breaks down.<br>Avoid wounding vegetables during cultivation and harvest to minimize sites of infection. *Store only sound vegetables without wounds.* | |
| *(Figure 2, page 82)* | **Cutworms** are grayish caterpillars which lie in a curled position just below the soil surface by day and feed at night. Most damage is done to seedlings and transplants which are cut off at ground level. However, some are climbers, such as variegated cutworm, which appear later in the growing season. Cutworms are most active during May and June.<br>Plants can be protected by placing cylinders made from empty cans (bottom removed) or from tar paper, partly buried in the soil, around each plant. This method is practical for cabbage, tomato and similar crops but not for peas, beans and other closely seeded crops. When chewed-off plants are found, scratch the soil to find the worm to avoid losing other plants.<br>Four methods of chemical control are available (check the label for the crops on which these insecticides may be used). | |

*continued on page 12*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **MANY VEGETABLES** | 1. To prevent cutworm damage, apply insecticide to soil *before planting* and mix into soil to a depth of about 5 cm. | chlorpyrifos (dust or granular)<br>diazinon (spray)<br>permethrin |
| | 2. If damage to growing plants is noticed, spray or dust plants and soil around stem. | carbaryl<br>chlorpyrifos (spray)<br>permethrin |
| | 3. Scatter bait pellets along the row or place pellets at the base of each plant. | carbaryl (bait) |
| | 4. To kill climbing cutworms, thoroughly spray the plant as well as the ground underneath when damage is seen. | carbaryl<br>permethrin |
| | **Damping-off** kills seedlings, particularly in the greenhouse or cold frame. This soil-borne disease can be expected annually unless sterilized soil, tools, and flats are used. | |
| *(Figures 51(a), 51(b), page 90)* | Moist conditions at the soil surface promote this disease. In order to facilitate rapid drying of soil surface, sow the seed thinly and thin seedlings when crowded. Water only when necessary and not late in the day. Ventilate cold frame or greenhouse regularly to create drier conditions. | |
| | Pasteurizing soil that is to be used for seeding in flats or pots greatly reduces the risk of damping-off disease (rotting of seedlings). Place 10 cm of moist soil in cans or metal trays in the kitchen oven at 82°C for one hour. Care must be taken not to exceed this time and temperature. Clay pots (not plastic) and metal tools can be treated in the same way. Peat moss is practically free from the damping-off fungus, and should not be heated in the oven as it will start to smolder. Sterilized potting soil is available at garden supply centres. Used plastic flats and pots should be scrubbed to remove soil residues and sterilized by soaking in a solution of 1 part 6% bleach in 9 parts water. | |
| | If soil has not been sterilized, apply this fungicide as preventive treatment by drenching the soil surface before seeding or transplanting according to label directions. This chemical may be applied on growing seedling plants when the disease develops, but only controls *Rhizoctonia* and not other fungi. | oxine benzoate |
| | **Earwigs** are reddish-brown and about 2 cm long with a pair of forcep-like appendages at the hind end. They feed only at night and hide by day in the soil, under stones or debris and on the underside of spinach, lettuce, rhubarb and other leaves. They feed on seedling carrots, beans and beets. They climb tall plants and can be found under husks of sweet corn. When many earwigs are found, spray or dust the soil, or scatter bait pellets around plants (preferably in June or early July). | carbaryl<br>chlorpyrifos (dust) |
| *(Figure 37, page 88)* | **Flea beetles** are small, black, active insects about the size of a pinhead. Early in the season, they eat many small, round holes in the leaves of potato, tomato, pepper, eggplant, cabbage, cauliflower, broccoli, Brussels sprouts, radish, rutabaga (swede turnip) and corn. Plants are usually not killed, but growth is delayed. Treat only if damage to foliage is severe. *Not all recommended insecticides are registered on all vegetables; apply only on crops listed on label.* | carbaryl,<br>chlorpyrifos (on potato only),<br>diazinon, methoxychlor,<br>permethrin (on cabbage, cauliflower, broccoli, Brussels sprouts only),<br>pyrethrins,<br>rotenone |

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| **Kind of Vegetable** | **Descriptions and Treatments** | **Use One of these Pesticides if Necessary** |
|---|---|---|
| MANY VEGETABLES | **Grasshoppers** may become a problem when a lush garden is situated near weedy areas, abandoned fields, woodlots, etc. This usually occurs when dry weather reduces the attractiveness of normal food plants, resulting in migration of grasshoppers into the garden. Young grasshoppers are much more susceptible than adults to insecticides. An alternative is to manually catch and destroy invading grasshoppers. | malathion |
| *(Figure 3, page 82)* | **Millipedes** are dark brown "worms" about 3 cm long with two pairs of legs per body segment, or about 100 or more legs. They are usually found hiding or curled up like a coil spring. They feed on manure and decaying organic matter and do little or no harm to plants. They should *not* be controlled. The millipede is often mistaken for a wireworm (see page 83) which is orange with 6 pairs of legs and can cause severe damage to plants. | |
| | **Slugs** and **snails** hide by day in dark, moist places and feed by night. The use of mulch aggravates the slug or snail problem. When injury to plants is noticed, place bait in small amounts (spoonful each) on soil at about 1 m intervals; cover bait with boards, bricks, etc., as it is *attractive and very poisonous to dogs and birds.* Moist bait attracts the slugs; if soil is dry, water lightly. *Do not apply bait on edible parts of vegetables.* | metaldehyde |
| | **Sowbugs** and **pillbugs** have flat, oval, gray-brown bodies, about 1 cm long, with 7 pairs of legs. They are found mostly in damp places under flowerpots, boards, etc., or in manure and decaying leaves. They seldom harm plants and are beneficial because they breakdown organic matter.<br>Thus, normally they should not be controlled. However, they have caused damage to young plants by feeding on leaves at night, and in some situations may require control. Populations are usually kept in check by thorough garden sanitation. | carbaryl (bait) |
| | **Walnut injury** caused by **black walnut** and **butternut** roots may be evident on many species of plants growing within the root zone of these trees. English walnut does not have this effect. Tomato is one of the most susceptible vegetables showing symptoms of wilting and complete collapse of the plants about the time the fruit begin to size. Other susceptible vegetables include broccoli, Brussels sprouts, cabbage, cauliflower, eggplant, peas, pepper, and potato. If trees are removed, the harmful effect remains for at least one year. For further information, see OMAF Factsheet, *Black Walnut Toxicity*, Agdex 246/80, Order No. 84-050. | |
| *(Figures 48 and 55, pages 90 and 91)* | **Weed killer injury** may occur on tomato and many other vegetables which are highly susceptible to 2,4-D and other herbicides used on lawns nearby. Symptoms are malformed, twisted leaves and stems. Use great care when applying a weed killer. Never use a lawn or weed sprayer for spraying insecticides or fungicides on vegetables. | |
| *(Figure 5, page 82)* | **White grubs** are the young of June or Japanese beetles, or the European chafer. They are plump, white larvae with brown heads, and found in the soil where they eat roots of plants. Various sizes can be found depending on age. | |
| *(Figure 10, page 83)* | **Wireworms** are orange, hard-bodied larvae with 6 legs; they also feed on plant roots. | |

*(continued on page 14)*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| MANY VEGETABLES | **White grubs** and **wireworms** are often abundant on land which was recently in grass sod. It is advisable to dig or till sod land for new gardens in spring (before mid-May) and delay the growing of vegetables until the following year. This also allows sod to decompose and aids weed control. If former sod land must be used immediately for vegetables, delay as long as possible and rototill the site thoroughly before planting. | |
| *(Figure 64, page 94)* | **White mold** is a fungus disease which can affect all vegetables except sweet corn. For description and control, see "bean", page 15. | |
| | **Wilt diseases** such as those caused by the soil dwelling fungi *Verticillium* and *Fusarium*, are usually first seen in hot, dry weather. These fungi attack plant roots, growing within and plugging the water conducting system of the plant. Because plants cannot get enough water and nutrients they wilt and produce a poor crop, or die completely. When the stem of an affected plant is cut across, brown staining is seen in the water conducting vessels.<br>Dig out and remove affected plants, roots and all, to reduce the further contamination of the soil with the disease. If *Verticillium* is suspected, do not plant strawberries, raspberries, or vegetables in the potato family (tomato, potato, eggplant, pepper) in that location for several years.<br>Some bacteria also cause wilt diseases, such as the bacterial wilt of cucumbers and melons. Controlling cucumber beetles (see page 22) and removal of affected plants provides control. | |
| *(Figure 67, page 94)* | **Virus diseases** cause malformation and growth distortions on many different types of garden vegetables. Cucumber mosaic virus causes a mottled yellow and green symptom on leaves of crops in the cucurbit family (cucumber, squash, pumpkin, melon). Fruits may be bumpy, malformed and colored with a yellow and green mosaic pattern. Many other crops are also affected, including tomato, pepper, spinach, celery, beans, peas, potato, rhubarb and others. Tobacco mosaic virus (TMV) causes a malformed, mottled, or mosaic pattern resulting from different colored patches on tomato leaves. Vines may be dwarfed, bearing fewer and smaller fruits. Peppers and other crops are also sometimes affected. These and other viruses are transmitted from plant to plant by insect carriers, especially aphids, or by tools, hands and other means of physical contact. | |
| ASPARAGUS | **Asparagus beetles** occasionally damage the "fern" stage of the plants. There are two species of beetles, one orange with black spots, the other metallic blue-black with 6 yellow spots; both are about 1/2 cm long. Larvae are olive-green or dark gray, emerging from dark, bullet-shaped eggs. When beetles or larvae are numerous or damage is noticed, spray or dust after cutting has been stopped. Spray new plantings not being harvested as soon as any beetles appear. Destroy nearby wild asparagus which could harbor beetles. | carbaryl<br>malathion<br>pyrethrins<br>rotenone |
| BEAN | **Leafhoppers** attack beans and may, at times, cause considerable damage by sucking the sap from the underside of leaves, causing them to be stunted, crinkled and roll upwards. The insects are about 3 mm long, pale green, and move quickly when the plant is touched, hence they are difficult to see. Treat as soon as insects or plant injury are noticed, particularly on the underside of the foliage. | carbaryl<br>diazinon<br>dimethoate<br>malathion<br>methoxychlor<br>pyrethrins |

*(continued on page 15)*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| BEAN | **Mexican bean beetle** larvae and beetles severely damage leaves, stems and pods of all kinds of garden beans including lima beans and cowpeas. The beetles spend the winter in plant rubbish. They may appear on beans in late June. Later, groups of orange-yellow eggs will be seen on the underside of bean leaves. Soft, yellow larvae develop from the eggs. They are up to 8 mm long with black-tipped spines on the back. They feed on the underside of leaves, removing the green matter and leaving the veins. They are seldom a problem except in the Niagara peninsula, and along Lakes Erie, St. Clair and southern Lake Huron.<br>Clean up all plant debris where the beetles will shelter over winter. Spray or dust when first seen.<br>The beetles belong to the same insect family as lady beetles and may be mistaken for them. The Mexican bean beetle is a dirty to coppery-yellow color with 16 black dots (8 on each wing cover). Do not mistakenly kill the beneficial lady beetles. | carbaryl<br>dimethoate<br>malathion<br>methoxychlor<br>pyrethrins |
| *(Figure 9, page 83)* | **Seed-corn maggots** attack either the seed, preventing germination, or injure the germ of the emerging seeding. The adult flies lay their eggs in May, preferably in recently manured soil. If possible, spread manure and till soil in the fall. Shallow seeding promotes quick germination and reduces damage. This insect is not a problem everywhere; be guided by local experience in previous years.<br>Late crops, sown after June 1 in southern Ontario (June 10 in northern areas), are damaged less than early seedings. No chemical control is available for the home garden. | |
| *(Figure 64, page 94)* | **White mold** can affect all vegetables (except corn) but it is usually first found on bush beans during periods of wet weather or repeated watering. The symptoms are browning and rotting of foliage, stems and pods with white cotton-like tufts and round, black fungal bodies. If wet conditions continue, this disease spreads fast. The fungus overwinters on the remains of diseased plants in or on the soil or compost pile.<br>Pull diseased plants as soon as noticed and discard them together with all fallen leaves in the garbage, or burn them. Do not work this refuse into the soil or compost. Also avoid watering on foliage and give wider spacing between plants when seeding to promote air circulation. No chemical control is available. | |
| BROAD, FAVA OR WINDSOR BEAN | These beans are different from green and wax beans. They are not plagued by any of the above mentioned bean insects, but they are often severely infested by aphids. (See page 11.) Plant broad beans as early in spring as possible, or start them indoors and set out as transplants. | |
| BEET, SWISS CHARD, SPINACH<br>*(Figure 12, page 83)* | **Leafminers** cause blister-like blotches on leaves. Normally, no control is required if only roots and stems are to be eaten; however, control is sometimes necessary on spinach and swiss chard.<br>Foliage damaged by **leafminers** should be discarded with garbage to reduce infestation in the following year. If leafminers are a problem on spinach, grow New Zealand-type spinach which is not attacked by these insects.<br>If injury by this insect is an annual problem, apply insecticide when first blotches are noticed. | diazinon<br>malathion |

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **CABBAGE, CHINESE CABBAGE, BROCCOLI BRUSSELS SPROUTS, KOHLRABI, RADISH, RUTABAGA (SWEDE TURNIP)** | **Alternaria leaf spot** is a fungus disease that occurs on leaves, heads of cabbage, cauliflower, broccoli, and other members of the cabbage family. Spots are brown, target-like with concentric rings, and develop felt-like dark brown mold growth in wet weather. The fungus can be seed-borne, or survive in infected crop residue for 2 years. Fungicide sprays should begin in late summer in anticipation of wet weather. | chlorothalonil |
| | **Bacterial black rot** affects all members of the cabbage family, including wild mustard (weed). The plants may become infected from the seedling stage to harvest and in storage (e.g., rutabaga). On cabbage leaves, a wilted, often yellowish V-shape may be seen on the leaf margin. The veins in the area may be black or dark brown. Darkened veins may be seen in leaf stalks and stems of rutabaga, garden turnip plants and kohlrabi roots. This may show as a black ring or arc if the stem or root is cut crosswise. The bacterium overwinters on and in the seed and in the plant refuse. Infected seed results in infected seedlings. The bacteria may be splashed onto healthy plants by rain, dew, and irrigation water. They may also be spread by tools and/or when working among cabbage, etc., when the plants are wet.<br>Buy hot-water treated seed to raise seedlings. Buy transplants from a reliable dealer. If black rot is found, collect all of the plant remains, burn them or send them out with the municipal garbage. | |
| *(Figure 7, page 82)* | **Root maggots** cause severe damage to young plants every year. Eggs are laid on the soil near plants, and the white maggots feed on the roots. The plants become stunted and turn blue-gray, while the edges of the leaves tend to curl. Young plants are usually killed; older plants survive, but growth is reduced. Injury is most severe on plants seeded or planted during May. Feeding injuries provide entry sites for root rot organisms. There are three generations of the adult fly which lay their eggs near these plants in May, early July and mid-August respectively. The first generation causes the most damage.<br>Avoid first-generation maggots by delaying sowing until early July (mid-June in Northern Ontario). Injury by the second- and third-generation maggots can be trimmed off before cooking. | |
| *(Figure 6, page 82)* | Sow the seed in a frame tightly covered with mosquito screen or cheesecloth to prevent maggot flies from laying eggs near the young seedlings. When transplanting into the garden, immediately place a collar around the stem of each plant. This collar is a square piece of tar paper or stiff plastic (about 10 × 10 cm) with a small hole in the center and cut to one side for sliding the collar around the stem. The collar must lie flat on smooth soil; it is helpful to place a small stone on the cut. | |
| | If the above protection methods are not followed, apply insecticide in seed furrow or around transplants *before or at seeding or immediately after transplanting*. | diazinon (granular) |
| | **Cabbageworms** are pale green caterpillars, and difficult to see because of their color. They often lie along the midrib of the leaf. They are a common, annual problem throughout Ontario. The presence of white butterflies is a warning that eggs are being laid. Treat when worms or holes in leaves are noticed and repeat throughout the summer as needed. | *Bacillus thuringiensis*<br>carbaryl<br>diazinon<br>malathion<br>methoxychlor<br>permethrin<br>rotenone |

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **CABBAGE, CHINESE CABBAGE, BROCCOLI, BRUSSELS SPROUTS, KOHLRABI, RADISH, RUTABAGA (SWEDE TURNIP)**<br>*(Figure 47, page 90)* | **Cabbage loopers,** 4 cm long when mature, are pale green caterpillars with white stripes along back and sides. They are easily identified by their "looping" movement. They feed on foliage and in some years can cause severe damage. Mature looper caterpillars are very difficult to kill. Spray or dust when they are small and repeat at 7-day intervals as needed. | *Bacillus thuringiensis*<br>carbaryl<br>permethrin<br>pyrethrins |
| | **Clubroot** is a very serious disease caused by a soil-borne fungus which will remain in the soil indefinitely. It cannot be eradicated by any chemical treatment or by a practical crop rotation. Garden soil can become infested by purchasing transplants or soil from infested fields. Infested soil clinging to tools and equipment may spread this disease. Cruciferous weeds are also attacked, and maintain the fungus in the soil in the absence of garden crucifers. Symptoms are large and small club-like swellings on the roots. In severe cases, the entire root system is deformed. As the fungus overwinters in these clubs as well as in the soil, carefully dig out all affected roots at harvest and discard them with the garbage. This should be done even if the soil was already infected before planting. When buying transplants, discard the whole flat or box if any affected seedlings are found. Acid soils favor development of the clubroot fungus. Incorporating agricultural lime into the soil to reduce the soil acidity (increase alkalinity) to a pH of about 7.2 makes it possible to grow these crops with fair results; have your soil tested. The addition of hydrated lime (available at a building supply) will change the pH more quickly; use at the rate of 1 kg / 6 m$^2$ and dig or rototill into soil about 3 weeks before planting. | |
| | **Downy mildew** is a fungus disease which primarily occurs in cool, moist weather in spring and fall. Yellow patches develop on leaves, later becoming brown and faintly netted with dark markings. The underside of these patches may be covered with a downy, white fungal growth under humid conditions. If observed, spray in anticipation of cool, moist weather. | chlorothalonil<br>copper |
| | **Mosaic virus** causes a long, crooked neck and a small, slender root on rutabagas and turnips. There is no chemical control for this virus disease. In late summer, **cabbage, cauliflower and broccoli** may also be affected, resulting in continuous drop of the lower leaves, long bare stems and poorly developed heads. If this disease is a problem, early planting is the only way to grow productive plants. | |
| **CARROT, PARSNIP**<br>*(Figure 8, page 83)* | During May, the first generation **carrot rust flies** lay eggs near plants and, from these eggs, maggots hatch and invade the roots. | |
| | Damage by maggots of the first generation of flies can be avoided by delaying seeding until July 1. This usually reduces populations of the second generation in late July, but some damage by the larvae may be expected. Plant these crops away from sheltered areas as this fly avoids windy locations. | |
| | If maggots are known to be a problem, apply insecticide in the seed furrow *before or at seeding;* maggots cannot be killed by pesticides when mature. | diazinon (granular or spray) |
| | The second generation rust flies lay eggs in late July. Apply spray to soil surface in the row if maggots are known to be a problem. | diazinon (spray) |
| **CARROT, CELERY** | **Leaf spots** and **blight** are quite common and cause foliage to turn brown or black. When first symptoms appear on the lower leaves, usually in late July, spray or dust 3 times at 7-day intervals. | chlorothalonil<br>copper<br>maneb*** |

****Vegetables treated with maneb should be washed before being eaten. After cooking, discard water used for boiling.*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **CARROT, CELERY, LETTUCE** | **Aster yellows** disease turns foliage yellow and may stunt growth. For description and control, see page 61. | |
| **LETTUCE** | **Downy mildew** is an occasional problem during cool weather in the fall or in a cold frame in spring. Treat as necessary. See page 17 for disease description. | maneb*** |
| **ONION, LEEK** | **Downy mildew** and **Botrytis leaf blight** are common diseases, causing withering of leaves, particularly on Egyptian tree onions, onions grown from sets and multiplier bulbs. Treat as soon as first injury is noticed and repeat at 7-day intervals. The diseases are particularly troublesome during wet weather or when there are repeated waterings. There will be less infection in the following year if diseased onion leaves and discarded bulbs are destroyed at the time of harvest. | maneb*** |
| | Proper drying of cooking onions for winter storage will discourage the bulb rot phase of Botrytis leaf blight. | |
| | **Thrips** may cause a stippling or streaking injury on the foliage. The small insects hide by day and are seldom seen. Treat when this injury is noticed, and repeat as needed. For leeks use only malathion. | diazinon<br>malathion |
| **ONION**<br>*(Figure 4, page 82)* | In some areas the **onion maggot** causes severe damage every year but in other areas this problem is not serious. Be guided by local experience. In May the first-generation flies lay their eggs near onion plants (seldom near leeks). The maggots attack the lower stem of the plant soon afterwards and tunnel inside; many plants die.<br>Onion sets planted after June 1 escape most first-generation maggots. This is too late for sowing seed. Buy sets early and store them in a refrigerator to keep them in good condition until planting time. Maggots from second-generation flies still may cause injury during late July and early August but the damage is not as great and plants are seldom killed.<br>The onion maggot problem is perpetuated by allowing this insect to multiply in your own and neighbors' gardens, particularly at the end of the season. The last-generation eggs hatch in mid-September. Therefore, if all onions are collected and destroyed there will be very few maggots to overwinter. This will reduce the problem considerably the following spring. | |
| | If onion sets are to be planted early to produce green onions or if seed is to be sown early, apply diazinon in the furrow at the time of planting or sowing. | diazinon (granular) |
| **PEAS**<br>*(Figure 14, page 84)* | **Seed-corn maggots** attack either the seed, preventing germination, or injure the germ of the emerged seedling. The adult flies lay their eggs in May, preferably in recently manured soil. If possible, spread manure and till soil in fall. Shallow seeding promotes quick germination and reduces damage. This insect is not a problem everywhere. Be guided by local experience.<br>Try to prevent the damage by seeding as early as possible so that the young plants are well established when the flies emerge to lay eggs. No chemical control is available for the home garden. | |

******Vegetables treated with maneb should be washed before being eaten. After cooking, discard water used for boiling.***

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| POTATO | **Leafhoppers** are described under beans on page 14. They cause burning of potato leaf margins (resembling disease) in midsummer. When these insects or the first damage is noticed, apply insecticide immediately, particularly on the underside of the foliage. | carbaryl<br>diazinon<br>dimethoate<br>malathion<br>methoxychlor<br>permethrin<br>pyrethrins |
| *(Figure 11, page 83)* | **Colorado potato beetles** are striped yellow and black. The larvae (grubs) are brick red with rows of black dots and cause more damage than the adult beetles. Eggplant, pepper and tomato may also be attacked. Apply insecticide only when injury is seen and repeat the application as needed. On a limited number of plants the beetles and grubs can be picked by hand and placed into a pail of soapy water. Resistance has been noted to many pesticides and for this reason hand picking is recommended wherever possible. | carbaryl<br>diazinon<br>dimethoate<br>malathion<br>methoxychlor<br>permethrin<br>pyrethrins<br>rotenone |
| | **Blister beetles** may cause more damage to potato leaves in northern Ontario than Colorado potato beetles. The treatment is the same. | |
| | **Alternative method to avoid damage by leafhoppers, Colorado potato beetles and blister beetles.** If the gardener does not want to apply an insecticide, the planting of an early or medium-early variety of potato will give an acceptable crop by mid-July when these insects usually destroy the foliage completely which stops any further growth of the tubers. Pre-sprouting the seed potatoes in open trays in the light during April and planting in early May will help to obtain a higher yield by mid-July. This method also eliminates damage by the **early blight** and **late blight** diseases. | |
| *(Figures 44, 45, page 89)* | **Late blight** may be a problem on potatoes under wet and cool weather conditions during late August and September. It is usually worse on low-lying, wet land and heavier soil (clay or clay loam) than on light, dry soil. Brownish-black blotches on margins of lower leaves are first symptoms. This disease originates from planting infected seed potatoes, so use only certified seed. It may also come from plants growing from infected tubers left in the ground the previous fall, or from nearby potato fields. When cutting seed potatoes, destroy all tubers showing dark spots or areas. The fungicides recommended for early blight are also effective for late blight, but as this disease only occurs in some years, preventive spraying may not be practical. Once the disease shows on foliage, it spreads so rapidly that spraying at this time is useless. Normally, the potato tubers are then about full grown and can be harvested without much damage from the disease if handled as follows: if late blight has infected the foliage in late summer, cut stems at ground level and *wait two weeks before digging*. These vines can safely be placed on the compost pile. If dug right away, the tubers become infected by the fungus spores on the ground or freshly cut foliage, and many will rot in storage. During digging, discard and destroy tubers with brown spots under skin. | |
| | **Several other diseases** may be brought into the garden on seed potatoes that affect quality and/or quantity of the crop. Such diseases will remain in the soil and infect potato plants for many years to come. Certified seed potatoes are generally free from these diseases. No chemical treatments are available. | |
| | **Poor sprouting of potato** Table potatoes bought in a food store are often treated to prevent sprouting, and will not develop into good plants. Always plant certified seed potatoes, or home-grown potatoes from healthy plants. | |

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **POTATO** | **Common scab** is a disease caused by soil dwelling, bacteria-like organisms. Roughened, sunken or upraised, discolored patches occur on the surface of potato tubers. Other root crops like beet, carrot, parsnip, rutabaga, and turnip can also be affected. Sometimes early infections are attacked by soil-dwelling insects, resulting in deep pits. Neutral to alkaline soil pH, fresh manure applications, and the use of infected potato seed pieces promotes this disease. Avoid liming the soil, try to keep soil pH at or below 5.2; use well-rotted manure; plant disease-free, certified seed potatoes; and avoid growing the above susceptible crops for at least 3 years in soil where scab has been a problem. Several varieties of potatoes are resistant or tolerant to scab, including Ontario, Superior, Onaway, Russet Burbank (Nettled Gem), Norchip, Belleisle, and Sebago. | |
| **POTATO, TOMATO**<br>*(Figure 41, page 89)* | **Early blight** occurs annually in most areas of Ontario by midsummer. Large, brown "target" spots appear on foliage and the disease gradually spreads from older leaves to younger foliage. Potato tubers or tomato fruit are rarely affected. However, if the calyx of the tomato is infested, the tomato fruit will drop before ripening. The fungus overwinters on diseased foliage. Burning all affected leaves and stems, or disposing of them with the garbage in the fall will reduce chances of infection next season. Widely spaced, well-pruned, staked tomato plants are less affected by early blight than a crowded planting. Plants that show poor growth are more susceptible than vigorously growing plants. | |
| | Chemical treatment is seldom warranted, if plants make rapid growth of healthy, young foliage because the edible portion of the crops are little affected. Repeated applications at 7- to 10-day intervals are required to protect young foliage, especially during wet weather or repeated watering. See note on alternative method for potatoes on page 19. | chlorothalonil<br>copper<br>maneb*** |
| | **Anthracnose** disease fungi cause sunken, circular spots which may coalesce and completely rot the fruit. Spots usually occur late in the season during cooler, wet weather on ripe fruit which contacts the soil. Keep tomatoes staked so that fruit is off the ground. Do not grow tomatoes in the same location each year because the disease persists in soil and crop residue. Fungicide sprays must begin when fruit are walnut-sized and continue at 7- to 10-day intervals until harvest. | chlorothalonil<br>copper |
| **SWEET CORN**<br>*(Figures 13, 35, pages 83 and 88)* | **European corn borer** larvae are about 2.5 cm long when full grown. They are a dirty-white or pinkish color with brown dots. Masses of eggs, resembling fish scales, are laid on the underside of the leaves near the midrib. First the larvae feed on the leaves, making small holes, then bore into the stalks, causing breakage, and feed on cobs and kernels. There are two strains of this insect in Ontario, one having two generations, the other only one generation, per year. The two generation per year strain occurs in the area south of a line between Simcoe, London, and Sarnia. Its eggs are laid on corn between early June and early July, and again from late July and early September. The one generation strain occurs throughout Ontario, laying its eggs from late June to mid-August. Both strains may be present in the same area at the same time. | carbaryl |
| | Two-generation area: When early corn is about 30 cm tall, or when egg masses are observed on these leaves, insecticides should be sprayed or dusted into the whorl twice at 5-7 day intervals. Spraying must begin no later than when pinhole-sized feeding damage is observed on young corn leaves; otherwise, the larvae will have already tunnelled safely into the plant without contacting the insecticide. The second generation is very difficult to control, and usually | |

*(continued on page 21)*

****Vegetables treated with maneb should be washed before being eaten. After cooking, discard water used for boiling.*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| SWEET CORN | occurs on late-planted corn. Make 4 applications at 5-day intervals when egg masses or first-feeding injury are observed. The first spray should be directed at the whorl, while all sprays after tassels appear should be directed at the ear zone.<br>One-generation area: Before tassels begin to appear in the whorl, at the top of the plant and when egg masses are observed, insecticide applications must begin. Make the initial application in the whorl, followed by two later sprays at 5-7 day intervals. All sprays after tasseling should be aimed at the zone where ears are being produced.<br>Caution must be exercised to avoid honeybee poisoning. Bees collect corn pollen from leaves as well as tassels, and will be killed by carbaryl and other insecticide residues if exposed.<br>The above treatments assume that the presence of corn borers in sweet corn ears is intolerable. To avoid the expense of above treatments, simply cut out infested areas on the cobs before consumption. | |
| *(Figure 35, page 88)* | **Corn earworm** In some years, the tips of corn ears can be infested with robust caterpillars having brown, green and yellow striped bodies. Because adult moths migrate into Ontario from the south, it is very difficult to predict when or if infestations will occur. In southwestern areas where earworms have usually been a problem, insecticides may be warranted. Four applications at 4-day intervals (3-day intervals during hot weather) are required, beginning when 25% of ears show silk. Otherwise, control is usually not necessary. | carbaryl<br>permethrin |
| | **Corn rootworm** Two types of beetles, one pale green, the other yellow with black stripes, each about 6 mm long, feed on corn silks and pollen. If the silk is eaten before pollination takes place, the ear will not fill properly. This is especially a problem on late-maturing corn. The larval stage feeds on and tunnels in corn roots. Because eggs are laid in fall in existing corn fields, simply plant corn in another area of the garden distant from last year's planting to avoid damage from larvae. Adult beetles are difficult to control on corn silks, except by covering the silks with screen caps to exclude beetles when practical. | carbaryl (Sanex Liquid Sevin) |
| | **Corn smut** galls may appear on any aboveground part of the corn plant. At first they are covered only by a thin silvery-gray membrane. When mature, the galls break open to release black spores which scatter and may survive in the soil or remains of the corn plant for several years. The overwintered spores germinate in early summer, producing other spores that infect corn. They are wind-borne and may come from corn fields in the vicinity or neighbors' gardens. To reduce infections, destroy smut galls on your corn before they burst open.<br>There is no chemical control. Consult your seed catalogue for information on sweet corn varieties which are resistant to smut. | |
| *(Figure 38, page 88)* | **Sap beetles** Small black beetles with 4 cream-colored markings sometimes infest corn ears, especially those with previous insect or bird injury, which have loose fitting or previously opened husks.<br>Avoid damaging developing ears, control corn borers, and use baits for control. (See page 37.) | carbaryl (bait) |

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **CUCUMBER, MELON, PUMPKIN, SQUASH, SWEET CORN** *(figure 14, page 84)* | In some areas, the **seed-corn maggot** may injure germinated seed or seedlings of corn and squash and sometimes cucumber. For description, see "beans," page 15. If these crops are known to be damaged by seed-corn maggot in an area, grow transplants in containers indoors or in a screened frame as suggested for cabbage root maggot prevention (page 15). Transplanting may then be done at any time. No chemical control is available. | |
| **CUCUMBER, MELON, PUMPKIN, SQUASH** | **Cucumber beetles** are a common problem. Young plants may be killed by defoliation. In addition, the beetles carry a bacterial disease which causes wilting and death of older plants. Cucumber beetles are striped yellow and black or yellow with black dots and are about 6 mm long. They move fast when disturbed. Treat when beetles are first noticed. Bees are active pollinators of this crop, so do not use malathion when plants are flowering. Rotenone is the safest pesticide for bees. See "Our Environment," page 2. | malathion<br>methoxychlor<br>rotenone |
| | **Leaf spots** and **scab** are common annual problems. Spray or dust as soon as noticed and repeat every 5 to 7 days as needed. These plants are pollinated by bees and some insecticides in multipurpose mixtures may be very harmful to them. (See "Our Environment," page 2.) Resistant varieties are available from seed suppliers. | carbaryl<br>chlorothalonil<br>copper (spray preferred)<br>maneb*** |
| | **Powdery mildew** appears as a dry talcum powder-like mass of white spores on the upper leaf surfaces during hot, humid weather. Spray when disease is first noticed, preferably as preventive measure. Use resistant varieties. | benomyl**<br>chlorothalonil<br>folpet |
| | **Squash bugs** attack mainly pumpkin and squash, but sometimes also attack cucumber and melon. Young bugs (nymphs) are gray; adults are dark brown and 17 mm long. They suck sap from leaves, stems and vines; affected areas are lighter in color at first and later turn brown and die.<br>These insects congregate at night under boards, stones, etc. In June, place such objects between plants and catch bugs each morning. These bugs overwinter in similar sheltered places. Tidy up around the garden at the end of the year to eliminate such shelters.<br>Treat when injury or bugs are noticed; repeat as needed. | carbaryl<br>methoxychlor<br>rotenone |
| | The **squash vine borer** enters and feeds inside the stems of the vines. Pumpkin, cucumber and melon are also attacked. Affected vines survive but may break later in the season. Fruit is poor and small. The insect overwinters in the soil and once it is in a garden, the problem occurs every year.<br>This insect lays large reddish-brown eggs on the stem near the soil in late June through late July. Destroy eggs before they hatch. When wilting of vines is noticed and the holes of the borer are noticed from the castings, slit stem lengthwise and remove borer. Mound soil over injured area and over vines near leaves to promote new root growth from stems. The variety "Butternut" is resistant to the squash vine borer.<br>Preventive spraying or dusting of the base of the vines is necessary. Make applications at weekly intervals starting in late June. | rotenone |

***See "Resistance to benomyl" on page 10.*

****Vegetables treated with maneb should be washed before being eaten. After cooking, discard water used for boiling.*

# CONTROL OF INSECTS AND DISEASES ON VEGETABLES

| Kind of Vegetable | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| TOMATO | **Tomato hornworms** are large, robust, and green (often not noticed) caterpillars with diagonal white stripes on sides, and a black horn on the hind end. Foliage of the tomato is eaten, leaving only the midrib. Holes are eaten in the green fruit. Hornworm excretion is often visible near the injury. Larvae develop in summer, pupating in soil late in the season. Search for the larvae near injury, hand-pick and destroy. Insecticides are rarely necessary. *Bacillus thuringiensis* is most effective if applied when caterpillars are very small. | *Bacillus thuringiensis*<br>carbaryl<br>diazinon<br>pyrethrins<br>rotenone |
| *(Figure 38, page 88)* | **Sap beetles** invade damaged tomatoes in great numbers. Gather and discard this damaged fruit. For description and control, see page 37. | carbaryl (bait) |
| | **A tomato strain of the late blight fungus** occasionally appears in home gardens. It is reduced or prevented by the fungicides used for early blight. If it appears, spray promptly and at short intervals if the weather is wet. | chlorothalonil |
| *(Figure 43, page 89)* | **Septoria leaf spot or blight** has been a common problem of tomatoes in recent years. The spots are reddish at first but later develop gray centers with black dots.<br>The small black dots are the reproductive structures of the fungus, within each spot. Spots will also occur on the stems and branches more readily than early blight. If this disease is a problem, apply fungicide and repeat at 7-10 day intervals. Hot-water seed treatment eradicates this as well as other seed-borne diseases, and is available from some seed companies. Disposal of affected foliage in the garbage will eliminate overwintering inoculum. | chlorothalonil<br>copper |
| | **Whiteflies** are small white bugs which actively fly when disturbed. Young white flies are found wingless, pale and scale-like on the underside of leaves. Cucumbers and other vegetables may also be infested. Also see page 60 for further description. | permethrin |
| *(Figure 42, page 89)* | **Blossom-end rot of tomato** is very common, especially in first ripe fruit. Blossom-end rot is a brown to black rot which becomes hard and leathery and occurs on the blossom end of fruit. Later, fungi or bacteria may enter and cause soft rot of the entire fruit. This injury develops when hot, dry weather alternates with periods of heavy rainfall, resulting in a deficiency of calcium which is the basic cause of blossom-end rot. It is not caused by either a pathogen or an insect. Excessive use of fertilizer may increase this disorder if it upsets the supply of calcium to the fruit. Mulches and careful watering to maintain uniform soil moisture helps reduce the loss. | |
| *(Figure 60, page 93)* | **Leafroll of tomato** symptoms are rolled edges of the leaves but the foliage has a healthy green color. It is not a disease caused by a fungus, bacterium or virus, but it is a disorder in the plant probably due to irregular water supply or severe root-pruning. It has no adverse effect on plant growth. | |

# KEY TO POSSIBLE FRUIT TREE PROBLEMS

**The following key is designed to help you narrow down the possible causes of problems on your fruit trees. Observe the symptoms on the injured portion of your tree and look in the corresponding portion of the key. Several possible causes may result in similar symptoms. Refer to the appropriate page numbers for detailed descriptions of some of the more common problems. If in doubt about your diagnosis, consult a qualified specialist for advice before attempting control.**

| Problem Descriptions | Possible Causes of the Problem | Page number |
|---|---|---|
| **A. Problems in Roots** | | |
| 1. Roots, rotted, few fine fibrous roots present, bark strips off roots easily, discolored brown wood underneath | 1. Root rot fungi (*Phytophthora*, *Armillaria*, etc.) | 66 |
| | Waterlogged soil | |
| | Tree planted too deep | |
| | Tree planted in improper soil | |
| | Nematodes | 49 |
| 2. Roots or lower stem with gall or tumor-like growth | 2. Crown gall bacteria | 27 |
| **B. Problems in Trunk and Branches** | | |
| 1. Sunken areas or discolored bark called cankers, in patches or completely surrounding a branch, often with cracked edges, or bark splitting or missing completely, or pimple-like structures in the dead bark, or gum production on the bark | 1. Canker-causing fungi | 32,62 |
| | Bacterial fire blight | 30 |
| | Winter injury (especially on the south and west sides of the tree) | 48 |
| | Improper pruning | |
| | Mechanical wound (lawn mower, etc.) | 48 |
| 2. Bark partially or completely missing, teeth marks in wood | 2. Field mouse (vole) or rabbit feeding | 74 |
| 3. Small holes of various sizes in bark, sawdust-like frass coming from holes or present in gum deposits covering the holes, tunnels underneath the bark | 3. Wood-boring insects (peach-tree borer, shot-hole borer, etc.) | 32,52 |
| 4. Brown-streaked staining in the wood of a branch cross-section, with or without bracket or shelf-like fruiting structures of fungi on the bark; often starts on one side of tree | 4. *Verticillium* wilt fungus | 68 |
| | Wood decay fungus | 69 |
| | Silver leaf fungus | 29 |
| 5. Swollen, dark olive green to black areas of bark on plum and cherry | 5. Black knot fungus | 33 |
| 6. Small twigs or entire branches die-back; buds brown inside, dried up or rotted | 6. Winter injury | 48 |
| | Canker-causing fungi | 32,62 |
| | Bacterial blights (fire blight, *syringae* blight) | 30,64,68 |
| | Brown rot (peach, plum, cherry) | 33 |
| | Borers | 32,52 |
| 7. Small bumps on the bark of various shapes easily removed with sharp object | 7. Scale insects | 28 |
| **C. Problems on Leaves** | | |
| 1. Leaves on entire or part of plant wilt, become discolored and die, or never emerge in spring, or emerge and die during spring | 1. Winter injury | 48 |
| | Plant girdled by borers | 32,52 |
| | Canker-causing fungi | 32,62 |
| | Girdling twine, wire or rodent feeding | 74 |
| | *Verticillium* wilt | 68 |
| | Root rot fungi | 66 |
| | Severe drought | 65 |

*(continued on page 25)*

| Problem Descriptions | Possible Causes of the Problem | Page number |
|---|---|---|
| 2. Leaves are discolored | 2. | |
| (a) turn black or brown on part of plant and remain attached | (a) Fire blight (apple, pear) | 30 |
| | Brown rot (peach, plum, cherry) | 33 |
| (b) become sticky with shiny honeydew, and covered with black, sooty mold | (b) Sucking insects | |
| | aphids | 31 |
| | scale | 28 |
| | pear psylla | 31 |
| | Sooty mold | 51,67 |
| (c) become speckled or discolored may dry out and turn bronzed or brown | (c) Spider mites, European red mite | 28 |
| | Leafhoppers | 56 |
| 3. Leaves are malformed | 3. | |
| (a) covered with white powdery mold | (a) Powdery mildew | 35,66 |
| (b) have warts or abnormal growths on them | (b) Gall mites (eg., pear leaf blister mite) | 31,55 |
| (c) puckered, contorted, stunted | (c) Peach leaf curl | 32 |
| | Aphids | 31 |
| | Pear psylla | 31 |
| (d) twisted, cupped, yellow | (d) Herbicide injury | 49 |
| 4. Leaves have dead spots or blotches | 4. | |
| (a) olive-green to black, felt-like, irregularly-shaped patches | (a) Apple scab, pear scab | 30 |
| (b) small orange, gray, tan, or brown spots on leaves; sometimes dried tissue falls out, leaving "shot-hole" symptom | (b) Frog-eye leaf spot on apple | 29 |
| | Cherry leaf spot on cherry | 33 |
| | Cedar apple rust | 63 |
| (c) margins dry and brown | (c) Physiological | 65 |
| 5. Leaves or portion of leaves are eaten | 5. | |
| (a) large holes in leaves | (a) Caterpillars | 27 |
| (b) green parts of leaves eaten, only veins remain | (b) Skeletonizers (eg., pear slug, caterpillars) | 31,52 |
| (c) leaves rolled or webbed together | (c) Tent caterpillars, leafrollers | 27,52 |
| (d) leaves with hollowed-out areas | (d) Leafminers | 30 |
| **D. Problems on Fruit** | | |
| 1. No fruit forms | 1. (a) Winter injury | 48 |
| | (b) Frost injury | 48 |
| | (c) Poor pollination | 27,48 |
| | (d) Excessive fertilization | 27 |
| | (e) Immature tree | 27 |
| 2. Fruit drops early | 2. (a) Normal "June drop" due to excessive fruit set; insect infestation inside fruit (curculio, maggots, caterpillars) | 26,28,30 |
| | (b) Carbaryl insecticide used just after bloom | |
| | (c) Excessive pest injury to leaves (tentiform leafminer) | 30 |
| 3. Fruit with blemishes | 3. | |
| (a) scar shaped like a half-moon present | (a) Plum curculio | 28 |
| (b) sunken dimples on fruit | (b) Apple maggot on apple or prune (Italian or Stanley) | 30 |
| | Plant bugs on apple, pear, peach | 29 |
| | Cherry maggot | 33 |
| (c) holes in fruit, sawdust-like frass or gum, or nothing coming from hole | (c) Codling moth on apple, pear | 29 |
| | Oriental fruit moth on peach | 32 |
| (d) tiny brown knobs on fruit, can be scraped off easily | (d) Scale insects | 28 |

*(continued on page 26)*

| Problem Descriptions | Possible Causes of the Problem | Page number |
|---|---|---|
| (e) rotted, tan to dark brown spots on fruit | (e) Fungus diseases (eg., black rot on apple, brown rot on peach, plum and cherry) | 29,33 |
| (f) dark olive green to brown felt-like patches on fruit, sometimes skin cracks associated with patches | (f) Apple scab, pear scab | 30 |
| (g) fruit rot on the tree or after harvest | (g) Fungal fruit rots | |
| 1. fruit covered with white and black whisker-like mold growth on rot, watery and soft | (1) *Rhizopus* rot (peach, plum, cherry) | |
| 2. fruit covered with grayish-brown velvety mold growth on soft brown rot | (2) Brown rot (peach, plum, cherry) | 33 |
| 3. fruit with firm, dark brown, target-like rot | (3) Black rot (apple, pear) | 29 |
| 4. fruit with watery, tan, sunken rot with blue-green and white tufted mold growth | (4) *Penicillium* rot (apple, pear) | |
| 4. Fruit small, poorly developed | 4. | |
| | (a) Excessive fruit set | |
| | (b) Reaction to nearby feeding of aphids | 31 |
| | (c) Pear psylla or other sucking insects | 31 |
| | (d) Cedar apple or quince rust infections | 63 |

# INSECT AND DISEASE CONTROL ON FRUIT

Fruit reasonably free of insect and disease injury can be grown by careful timing of sprays and thorough application of the correct pesticides. It is essential that good cultural practices are followed, such as destroying affected fruit and prunings.

Where fruit is grown in isolated areas away from a commercial production area, some of the pest problems mentioned may not occur. Spraying for those pests would be unnecessary and unwise. It should be kept in mind, however, that neglected and wild apple trees grow in many parts of Ontario. These trees are a source of harmful insects and diseases.

Dust mixtures for fruit are available, but they are not as effective as sprays.

## Insects

To control certain insects, it is necessary to apply preventive sprays before eggs are laid in the fruit. The recommendations on the following pages clearly indicate those insects for which preventive spraying is required.

## Diseases

Preventive fungicide applications are necessary to protect foliage and fruit against infection by spores of disease-causing fungi. Most fungicides applied after infection takes place fail to stop the development of diseases; however, they may prevent further spread. Repeated applications of a fungicide are necessary to protect new foliage as it develops and to renew the protection of foliage and fruit sprayed earlier.

Rain favors the development of most diseases, however, powdery mildew thrives in warm, humid weather without rain. It is advisable to apply fungicides before rainfall rather than afterwards. The residue should be dry on the foliage **before** rainfall to reduce pesticide loss during rainfall.

## Rate of Application

Read the label on the pesticide container for the proper rate of application. Also see the discussion on page 6.

## Recommended Insecticides and Fungicides

The recommended pesticides on the following pages are listed by their common chemical name in alphabetical order, not in order of preference. The common chemical name of the active ingredient(s) of each product appears on the front panel of the label following the "guarantee." The lists of available pesticides on pages 77-81 relate the common chemical names to the corresponding products sold in Ontario. These tables also indicate which products may be used on fruit trees, small fruits or grapes.

Where "insecticidal soap" is recommended, the labelled and registered product should be used — NOT household soaps and detergents, as they could damage plants and may not be effective.

### Resistance to Benomyl Fungicide

By using benomyl exclusively to control a certain disease, strains of the causal fungus that are resistant will escape, multiply, and then become uncontrollable by benomyl. By alternating between benomyl and another fungicide, the development of resistance can be delayed or avoided.

### No-Spray Interval Before Harvest

To avoid harmful residues on the fruit, the trees or plants may not be sprayed or dusted closer to harvest than this interval. This period varies for each product and each kind of fruit. Consult the product label for the no-spray interval and follow the instructions carefully.

### Mixing Products Together

Most insecticides and fungicides can be mixed together in the sprayer if necessary. Always add the wettable powder to the water first, then stir before adding any liquid product. Never mix captan with dormant oil, and do not mix lime sulfur with any other pesticide. Never mix more than two products together. To avoid the development of resistance, never mix two products for the control of the same pest together.

### Crab Apples

Crab apples are usually considered to be ornamental trees and therefore are included in that section of this publication. If grown for their edible fruit, their treatment is the same as for apple.

### Prunes

Italian and Stanley varieties may be attacked by the apple maggot, whereas other plums may not. All other control measures for prunes are the same as for plums.

### Blueberries

In Ontario, blueberries have few insect and disease problems. Furthermore, no domestic pesticides are registered for this crop.

### Poor Pollination and Fruit Set

Poor flowering can occur for several reasons. Temperature extremes or fluctuations during the winter may kill all flower buds (see discussion under winter injury, page 48). Early spring frosts, after the flower buds have begun to swell, can also cause death of the temperature-sensitive flower tissue. Overly vigorous vegetative growth during the previous growing season because of over-fertilization or excessive pruning can result in the failure of the tree or shrub to set flower buds.

Poor fruit set may occur because the pistil and stamens of the flowers were damaged prior to blooming, preventing pollination and fertilization from occurring, yet the petal tissue was not injured. Cool, wet weather during bloom discourages pollination by the bees, thus reducing the fruit set. Some fruit are self-fruitful; that is, they will pollinate themselves without requiring a second cross-pollinating tree. Sweet cherries are cross-pollinated and require other cherry trees with compatible pollen to be planted in the area for pollination to occur. Apples require varieties with a similar flowering date to achieve good pollination and fruit set. For further information, see OMAF Factsheet, *Compatibility and Pollination of Fruit Varieties*, Agdex 206/26.

Be sure you purchase named, known varieties of fruit which are compatible for cross-pollination. Otherwise, you may be disappointed when no fruit appears after the long wait for fruit trees or shrubs to come into bearing.

### Spray Programs for Tree Fruits

The need for preventive control of many fruit insects and diseases has been explained. It is easier to achieve this by following a spray program, particularly for tree fruits. In addition to the descriptions and recommendations for individual insects and diseases, this chapter also contains spray programs for apple, pear, peach, plum, cherry, nectarine and apricot.

## CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **ALL FRUIT** (except strawberry) *(Figure 69, page 94)* | **Crown gall** is caused by a soil-borne bacterium that is present in most garden soils. This disease is common on all types of **fruit trees, raspberries, grapes, bush fruits, and many other plants.** Galls or woody swellings develop on the roots or the base of the plant. The bacteria gain entrance through wounds. No chemical control is available. Avoid unnecessary wounds. Do not buy plants with galls on roots. Replace soil where a severely affected plant has grown before replanting. | |
| | Several kinds of **caterpillars** damage fruit trees. The **tent caterpillar** is the most common. Leafrollers also web up individual or small clusters of leaves, feeding inside the protected area. | |

*(Continued on page 28)*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **ALL FRUIT** (except strawberry) *(Figures 18 and 19, page 85)* | When tents (webs) are noticed in spring, destroy them by crushing, or cutting off the twig. Do this in the evening when most worms are in the tent. In early spring, look for egg masses on twigs and prune out or rub them off. Egg masses are dark brown, styrofoam-like collars, about 1 cm wide around small twigs and branches. | |
| | Spray only if many tents are found or if other caterpillars (not having tents) are a problem. It is important to apply insecticides before leaves are rolled and tied together, because caterpillars must consume or contact the residue, and will not if protected in a silken shelter. Carbaryl causes dropping of small apples if applied during 3-week period after bloom. | carbaryl<br>diazinon<br>permethrin<br>phosalone*<br>phosmet* (not on sweet cherry) |
| *(Figure 15, page 84)* | **Curculio** is a small weevil that lays eggs in apple, pear and plum, and occasionally peach and cherry fruits soon after flower petals have fallen. A crescent-shaped scar develops on the fruit. The larvae tunnel in the fruit and cause it to drop early. Spray after bloom as soon as most petals have fallen and repeat 10 days later. Carbaryl used at this time causes dropping of small apples but does not have this effect on other fruit. | carbaryl<br>methoxychlor<br>permethrin<br>phosalone*<br>phosmet* (not on sweet cherry) |
| *(Figure 31, page 87)* | **Mites** are spider-like pests which feed on the underside of leaves. Because of their small size, they are difficult to see without the aid of a hand lens. Control measures are not necessary unless the foliage starts to turn bronze, usually during or after hot weather. | |
| | Dormant oil can be applied in the spring at the *Half-Inch Green Stage* to kill red mite which overwinters on the fruit trees, but not other mite species which overwinter elsewhere. (Figure B, page 40). | dormant oil spray |
| | Sprays for other pests (except carbaryl and methoxychlor) may keep mite populations at acceptable levels, making special mite sprays seldom necessary. Repeated use of carbaryl for the control of other insects may lead to an increased mite population. | dicofol*<br>dimethoate (for severe infestation only)<br>insecticidal soap |
| | *Caution: If applying dormant oil for scale control, do not use for mite control.* | |
| | See additional caution for using dormant oil below under scale insects. | |
| *(Figure 22, page 85)* | **Scale insects** live under hard-shelled caps (scales) on the bark of trees. Depending on the species, the scales look like small gray oyster shells or round brown knobs. The tiny insects underneath the scales cause damage by sucking the sap of the tree. A light infestation may be kept in check by birds and beneficial insects but, if severe, spray the following spring *before leaf buds break*, thoroughly wetting all bark. Dormant oil may cause some bark injury on the apple variety Red Delicious. *Caution: spray oil in the morning to allow quick drying of the spray. Injury will occur if oil spray is not completely dry before a cold night.* | dormant oil<br>lime sulfur |
| | Effective control of scale on fruit trees can only be achieved by an early spring dormant bud application. (Figure A, page 40). | |

**Only available in multipurpose mixtures (see pages 5, 80).*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **ALL FRUIT**<br>(except Strawberry) | **Silverleaf** is caused by a fungus which invades the tree through pruning wounds. Apples, apricots, gooseberries, peaches, plums, raspberries and sour cherries, as well as several woody ornamentals are susceptible to this disease. Symptoms include the development of a metallic, silver sheen on the leaves of infected branches, and browning and streaking of the heartwood and sapwood. Branches or entire trees may be killed once the sapwood is invaded. The fungus produces shelf-like fruiting bodies up to 2.5 cm in diameter on the undersurface of horizontal branches and in bark crevices. The fruiting bodies are abundant after autumn rains and are a bright purple at this time.<br>To prevent infection, maintain vigorous trees. Avoid pruning trees from sap flow in the spring until after bloom, when they are most susceptible to infection. If possible, avoid large pruning cuts. Remove dead trees and tree branches in the vicinity which might be sources of the fungus. The removal of affected branches may or may not save an infected tree, as often the fungus is well established throughout the tree by the time of symptom development. | no chemical control |
| *(Figures 32(a), (b), 39, pages 87 and 88)* | **Plant bugs** cause sunken pits in apples, peaches, pears, and nectarines as a result of their feeding. Injury from their piercing and sucking mouthparts prevents fruit expansion at feeding sites, while the rest of the fruit continues to fill normally. Peaches, apricots and nectarines may also have amber gum secretions associated with these pits. See page 58 for further descriptions. Insecticide may be applied when plant bugs are first noticed in spring, especially after flowering when young fruits are expanding, and later when migrating adults appear. | carbaryl<br>permethrin (not on pear) |
| **APPLE, PEAR**<br>*(Figure 16, page 84)* | **Codling moth** lays eggs on the fruit of apple and pear. The larvae enter the fruit upon hatching and growing to maturity (2 cm) inside. Dark sawdust-like material is evident at the entry hole. Infested fruit often drops before maturity.<br>Regularly gather and destroy dropped fruit by throwing it in the garbage can or burying it at least 60 cm deep. This will reduce the insect population next summer.<br>As eggs are laid from mid-June until mid-August, spray at about 12-day intervals during that period. Sprays for codling moth and apple maggot are similar in timing and material (except for dimethoate). Using one of the insecticides listed for both insects is advisable. Observe the no-spray interval before harvest as stated on the product label. | carbaryl<br>diazinon<br>permethrin<br>phosalone*<br>phosmet* |
| | A fungus disease which causes **black rot** on fruit and **frog-eye leaf spot** on foliage often occurs on unsprayed apple trees in late summer. Small, tan-centred spots with darker borders occur on leaves, hence the name "frog-eye". Small, purple or red spots turn dark brown as they expand on the fruit, and may have target-like rings of black specks in older, larger spots.<br>These fruit will rot completely in storage. The fungus survives in cankers, dead twigs, and fruit on and under the trees. The spray programme for apple scab will also control this disease. See pages 30, 39. | |

**Only available in multipurpose mixtures (see pages 5, 80).*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **APPLE, PEAR** | **Fire blight** is caused by bacteria and is most serious on pears. It occasionally affects apples. Blossoms are the first part of the plant to become infected and they turn black and shrivel. The disease spreads to spurs and leaves, and later young twigs turn black. Warm weather and high humidity or rain favor the spread of this disease. Remove and destroy infected twigs 25 cm below the affected part. If pruning shears are used, disinfect blades in a solution of 1 part chlorine bleach in 4 parts water after each cut. Avoid heavy application of nitrogen fertilizer. Abandoned pear trees and rosaceous ornamental plants will harbor this disease. No chemical control is available. | |
| *(Figures 46 and 50, pages 89 and 90)* | **Scab** is the most common and serious disease of apples throughout Ontario. Pears are occasionally affected, especially the variety Flemish Beauty. Symptoms are spots on leaves, first olive-green, then turning dark brown and black. On fruit, dark spots are irregular in shape; if severe, the skin cracks and fruit is deformed. Leaves may drop and the crop in the following year may be reduced. The fungus which causes the scab, overwinters on dead leaves on the ground. In spring, when rain wets these leaves, fungus spores are discharged into the air and infect young apple leaves and blossoms. Prevention of this infection by covering leaves and blossoms with fungicide spray is the only effective control. In spring, new foliage develops rapidly and requires protection by repeated spraying. Once scab fungus becomes established on the tree, it causes repeated new infections with each rain. First spray should be applied when tips of the green leaves appear. Repeat at 5- to 7-day intervals until mid-June. If no scab is visible, fungicide applications can be discontinued. If scab is visible, continue fungicide applications but on a 10- to 14-day schedule until mid-August. Fungicides are not harmful to bees. As the scab fungus overwinters on fallen leaves, it helps to gather leaves in fall and either burn them or throw them in the garbage can, bury them in the soil, or compost pile. However, if there are neglected apple trees in the immediate area, this practice is not effective. | benomyl** (not on pear)<br>captan<br>ferbam*<br>lime sulfur (not on pear)<br>sulfur (spray)<br>(Do not use captan with dormant oil or within 10 days of an oil spray.) |
| **APPLE, PLUM** | **Tentiform leafminers** cause speckled blotches of hollowed out leaf tissue which are upraised like a tent. Adults are tiny (3-4 mm long), brown and white marked moths. There are 3 generations per year. In spring the first begins when eggs are laid on the underside of new foliage at the tight cluster to pink stage of apple tree growth. Larvae feed between leaf surfaces for about 4-5 weeks, pupate in the mine, and emerge to complete one generation.<br>Low to moderate levels of leafminer (1-7 mines per leaf) do not require control. If leafmining has been severe, fruit sizing poor, and premature fruit drop has occurred, then next season's first generation must be controlled to prevent late season build-up and indirect injury to the apple crop.<br>The trunk and large branches must be thoroughly sprayed as well as the foliage. Be sure *not* to spray permethrin when apple blossoms are open, as pollinating bees will be killed. | permethrin |
| **APPLE, PRUNE** (not plum)<br>*Figure 17, page 84)* | **Apple maggot,** or **railroad worm,** is an annual problem in most areas of Ontario. The small fly lays its eggs on the fruit of apple and Italian or Stanley prunes (not plums) from late June until mid-August. The small maggots make extensive tunnels in the fruit. The surface of apples becomes bumpy and much of the fruit drops before maturity. When full-grown, the maggots move from the overripe apples and prunes into the soil under the trees where they overwinter. | carbaryl<br>diazinon<br>dimethoate<br>permethrin (on apple only)<br>phosalone*<br>phosmet* |

*(Continued on page 31)*

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**Only available in multipurpose mixtures (see pages 5, 80).*

***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **APPLE, PRUNE**<br>(not plum) | Gather the fruit as it drops and throw it in the garbage can or bury it at least 60 cm deep. This will greatly reduce the number of maggot flies and damaged fruit the following summer. Encourage your neighbors to do the same. Destroy wild and unsprayed apple and prune trees, as well as hawthorns in the vicinity if possible.<br>The flies must be killed by insecticide deposited on the leaves and fruit before egg-laying. Spray about every 12 days from late June until mid-August, but observe the no-spray interval as stated on the product label. If unsprayed apple trees are in the neighborhood, this insect is very difficult to control. | |
| **APPLE** | **Powdery mildew** is sometimes a problem on young shoots of apple trees. The most susceptible varieties are Cortland, Idared and Jonathan. It causes distorted, rolled leaves with white fungus growth on the upper surface. Spray when noticed and repeat until the symptoms disappear. | benomyl**(not on pear)<br>dinocap*<br>sulfur |
| *(Figure 1, page 82)* | **Rosy aphid** causes clusters of dwarfed apples and rolled leaves. If this was a problem during the previous year, spray just before blossoms open but not during bloom. | dimethoate<br>phosalone* |
| **APPLE, CHERRY**<br>*(Figure 1, page 82)* | **Aphids** are a common problem on apple and sweet cherry and less so on sour cherry. They attack the growing end of twigs throughout the summer, sucking sap and causing leaves to curl. When severe, the fruit can also be affected. If aphids infested sweet cherry in the previous year, spray when leaf buds break. Control is very difficult once this insect becomes established and cherry leaves are curled. On apple, a sooty deposit is found on the fruit. Spray apple trees when aphids are abundant and repeat as necessary. Insecticidal soap is not effective for cherry aphid. | diazinon<br>dimethoate<br>insecticidal soap<br>phosalone* |
| **PEAR**<br>*(Figure 20, page 85)* | **Pear leaf blister mite** causes blisters and dark, dead spots on the leaves of pear. If severe, the tree may be weakened. Spray *before leaf buds break* if this insect caused severe damage to foliage in the previous year. | lime sulfur (dormant oil is not effective) |
| | **Pear psylla** The drop of honeydew which surrounds the insect is the most obvious symptom on the foliage. Later the honeydew turns black and sooty. Hot weather before and during blossom period favors heavy infestation. If severe, leaves turn pale with dead areas, fruit is dwarfed and trees are weakened. There are several generations per season, hence the honeydew may also be found in late summer. Spray when honeydew is noticed and repeat at 12-day intervals. | carbaryl<br>insecticidal soap<br>permethrin<br>phosalone*<br>phosmet* |
| | A dormant spray at the *Half-Inch Green Stage* reduces psylla infestation (Figure B, page 40). *Caution: If applying dormant oil for scale control, do not use for psylla control.* | dormant oil |
| **PEAR, PLUM, CHERRY**<br>*(Figure 23, page 85)* | **Pear Slug** is the larva of a sawfly and is not a true slug. This slime-covered larva is dark green at first and later turns orange. It is about 1 cm long and feeds on the leaves of pear, cherry and plum, leaving only a framework of veins.<br>Dusting these larvae with talc or dry, fine soil is effective because it causes them to dry out.<br>Any insecticide used during the summer against other fruit insects also controls pear slugs. | insecticidal soap |

**Only available in multipurpose mixtures (see pages 5, 80).*
***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **PEACH, APRICOT, NECTARINE** | **Canker** occurs on the trunk and branches. First symptoms are sunken areas on the bark; a gummy substance is visible and later the bark separates from the wood. The cankers increase in size year by year. Fungus infection takes place through wounds. Avoid bark injury, long pruning stubs, winter injury, brown rot injury to twigs and control peach tree borers. Prune trees in spring (not fall) and treat wounds with a tree dressing; remove any dead wood before the end of June. Do not prune in cool, wet weather, as this promotes infection. Healthy trees growing on well-drained, deep, sandy soil are less likely to get cankers. Do not apply fertilizer after June. | |
| **PEACH, NECTARINE** *(Figure 52, page 91)* | **Leaf curl** causes foliage to curl; later reddish blisters appear; finally, leaves turn yellow and drop. The tree is weakened if this disease occurs several years in succession. One preventive spray applied in spring *before buds break* or in autumn after leaves have fallen is necessary to control this disease; treatments later in spring or summer are not effective. | ferbam*<br>lime sulfur |
| | **Oriental fruit moth** is the cause of "worms" in peaches. It is a problem in areas where peaches are grown commercially, and may not occur in isolated locations. The first larvae enter the young twigs, which wilt and die. Later generations enter ripening fruit. Spray between July 1 and 10, depending on geographic location, and repeat 2 weeks later. Observe the no-spray interval before harvest as stated on product label. | carbaryl<br>permethrin<br>phosalone*<br>phosmet* |
| **PEACH, PLUM, NECTARINE, APRICOT (cherry is sometimes attacked)** | Two species of **peach tree borers** attack peach trees and sometimes plum. The insects or their larvae are seldom seen, but a gummy substance on the trunk from ground level (including exposed roots) up to and including larger branches indicates their devastating work. Gum may also appear at wounds and on winter-injured bark. Wounds from mechanical or winter injury, and canker disease, are places of entry for the borers. Young trees may be killed, but older trees are able to survive light borer attacks for a few years; however, they also become weak after several years and may eventually die unless borers are controlled. | |
| | Since young, transplanted trees are especially susceptible, wrap strong paper around the trunk from ground level up to the lowest branch. Leave wrapping in place for *at least* 2 years after planting. Do not use tar paper as the fumes may be injurious to the trees. Any wounds caused by pruning heavy branches or by accidents (e.g., lawn mower) should be scraped clean and treated with tree dressing or pruning paint. | |
| | For established trees, spray all bark of trunk and scaffold branches thoroughly, beginning 10 days after petal fall, 3 weeks later and again 3 weeks after second application. Correct timing is important, since only the adult can be controlled. | endosulfan<br>lindane (spray) |
| | Avoid spraying fruit and foliage as much as possible. When spraying, wear a long-sleeved shirt and pants; wash face and hands afterwards. | |
| | If a tree is infested with borers, remove gum and poke flexible wire into the holes to kill borers which can be reached. Then sterilize with a solution of 1 part bleach in 4 parts water and seal hole with putty or similar substance. This should be done in the spring and fall. | |

**Only available in multipurpose mixtures (see pages 5, 80).*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **PEACH, PLUM, CHERRY, APRICOT, NECTARINE**<br>*(Figure 61, page 93)* | **Brown rot** is a fungus disease affecting various parts of the tree. Infected blossoms shrivel, twigs are killed, fruits rot rapidly and are covered with gray mold (even after harvest). Such fruit may drop or hang on the tree throughout the winter. Twigs may also be killed by this disease. Spray when disease symptoms are first noticed and repeat at 2-week intervals until late July. If brown rot occurred in the previous year, spray when blossom petals fall and repeat about 10 days later; spray again about July 1-10 (depending on geographic location) and repeat about 14 days later. If brown rot is present and wet weather prevails, further sprays may be needed. Observe no-spray interval before harvest as stated on product label. | benomyl**<br>captan<br>sulfur |
|  | Where infected (moldy) fruit is still hanging on the tree or lying on the ground, it should be thrown in the garbage can or buried to reduce infection next summer. Cut dried fruit (mummies) out of trees when pruning; dispose of them in the same manner. |  |
| **PLUM, CHERRY**<br>*(Figure 49, page 90)* | **Black knot** is primarily a disease of plum trees, but it sometimes affects cherry. It causes hard, black swellings up to 10 cm long on branches and small twigs. |  |
|  | Remove and burn all knots when pruning or as soon as noticed, since early pruning will minimize spread. Make the cut at least 10 cm below knot. Destroy nearby wild and/or neglected plum and cherry trees. |  |
|  | Spray when leaf buds start to break. | lime sulfur |
| **CHERRY**<br>*(Figure 21, page 85)* | **Cherry maggot** is related to the apple maggot. The fly attacks the fruit of sweet and sour cherries in a similar manner to apple maggot (see page 30). |  |
|  | A cherry crop infested with maggots is not worth harvesting. If fruit is allowed to drop and rot under the tree, the insects will overwinter in the soil under the tree and a very large number of maggot flies can be expected next summer. Gather infested fruit and discard it in the garbage can or bury it at least 60 cm deep. Encourage your neighbors to do the same. |  |
|  | Spray between July 1 and 10, depending on geographic location. If cherry maggot was a serious problem in the previous year, apply a spray 10 days earlier (June 20 to 30). Observe the no-spray interval before harvest as stated on product label. If unsprayed cherry trees grow in the neighborhood, control is usually unsatisfactory. | carbaryl<br>diazinon<br>dimethoate<br>phosalone* |
| *(Figure 54, page 91)* | **Leaf spot** often occurs on sour cherry, but rarely on sweet cherry. Leaves first show many small red-purple spots, turn yellow and drop. The tree is weakened particularly if this happens during successive years. When leaf spot has been a problem, or is first noticed, spray when blossom petals fall and repeat about 10 days later; spray again between July 1-10 and after harvest. Observe no-spray interval before harvest as stated on the product label. | benomyl**<br>captan |
| **CURRANT, GOOSEBERRY**<br>*(Figure 1, page 82)* | **Aphids** are often a serious problem on currants, especially red currants, but seldom on gooseberries. They cause leaves to pucker, curl and show red blisters. If this problem has occurred before, spray when leaf buds open in spring and repeat about 10 days later. Early season applications are critical, since aphids are very difficult to control once the leaves are curled. | insecticidal soap<br>malathion |

*(Continued on page 34)*

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**Only available in multipurpose mixtures (see pages 5, 80).*

***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **CURRANT, GOOSEBERRY** | **Boring** and **girdling insects** cause injury to the wood. Affected shoots look sickly and later die. These shoots should be cut out when noticed at any time of the year. All shoots older than 3 years are unproductive and should be removed in spring before leaf buds break. All prunings must be burned or removed with garbage. Apply manure to promote vigorous growth of new canes. | |
| | The larvae of the **currant sawfly** eat the foliage of gooseberries and red or white currants (not black currants). Treat immediately when these worms first appear and repeat as needed. | methoxychlor<br>rotenone |
| | **Leaf spot** diseases are often the cause of early defoliation. Spots are first brown and later turn gray. Leaves turn yellow and drop. | |
| | Gather and destroy infected leaves after they have dropped. As these plants are often grown in isolated locations, this sanitation method may be very effective if done thoroughly. Where mulches are used, apply fresh mulch after leaf fall. | |
| | If leaf spot disease has been a problem in previous years, apply a preventive spray just before blossoms open. If leaf spots still develop, spray again after bloom. | copper |
| | **Maggots** in the fruit are larvae of the currant fruit fly. Infested berries ripen prematurely and many drop to the ground. To control this insect, it is necessary to kill the flies before they lay eggs in the fruit. Treatment is necessary if maggots were a problem last year. On currants, spray just after bloom and again a week later. On gooseberries, apply when berries turn red. | malathion<br>methoxychlor<br>rotenone |
| *(Figure 58, page 92)* | **Powdery mildew** is mainly a problem on gooseberry and black currant. The white mildew turns to a brown, felt-like coating on foliage, twigs, and fruits. Hot, humid weather favors the disease. Spray before buds break in spring and again just before bloom. | |
| | On gooseberries repeat weekly from fruit set until fruit colors. | |
| | Spray (only with lime sulfur) before buds break. | lime sulfur |
| | One of the three fungicides can be used after budbreak. | copper<br>lime sulfur<br>sulfur |
| | *Caution: Follow instructions carefully on the product label when using lime sulfur, because dormant concentrations are stronger than those used after budbreak, and will injure leaves if applied too late.* | |
| *(Figure 65, page 94)* | **Rust fungus** (white pine blister rust) spends part of its life cycle on white pine. (Pines may be killed after many years.) Although it occurs on all currants and gooseberries, it defoliates only black currants. Orange spots, later growing into pimples, appear on the lower surface of leaves. Spray just before bloom and again after harvest. The black currant variety "Consort" is resistant to white pine blister rust. For white pine blister rust, see page 66. | lime sulfur<br>sulfur |
| | If **scale insects** are found on shoots, spray thoroughly *before leaf buds break.* Spray dormant oil in the morning to allow drying before a cold night. | dormant oil<br>lime sulfur |

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **GRAPE** | **Berry moth** is a problem only in areas where grapes are grown commercially. If "wormy" fruit has been a problem in the past, spray soon after blossoming period and again 12 days later. If it has been a serious problem, also spray just before bloom and on late varieties again about August 20. | diazinon<br>permethrin<br>phosalone*<br>phosmet* |
| | **Black rot** may be a serious problem on the grape varieties Catawba, Concord, Agawam and Niagara. This disease causes many berries to rot shortly before harvest, spreading rapidly over the bunch. Preventive sprays have to be applied just before and again shortly after bloom. | benomyl**<br>copper<br>ferbam* |
| | **Downy mildew** appears early in the season and affects tendrils, shoots and fruit clusters, covering these with heavy, white, downy fungus growth. Fruit clusters may be completely destroyed. This disease is more serious in wet seasons and is favored in sheltered areas that have poor air drainage. Spray just before bloom but after flower clusters have expanded; additional sprays may be necessary, depending on weather and disease conditions. See note on varieties below in the powdery mildew section. | captan<br>copper<br>folpet |
| | **Grape flea beetle** is a shiny, metallic, greenish-blue beetle which attacks opening buds in spring. It is 4-5 mm long, actively jumping when disturbed. Larvae are black-spotted grubs which feed on leaves. Examine vines in May, and if buds are infested, use an insecticide or, if practical, knock the adults off into a pail of soapy water. | diazinon |
| *(Figure 63, page 93)* | **Powdery mildew** usually appears later than downy mildew but may be present just after bloom. It affects all new growth; blossoms wither and drop, whitish patches appear on upper leaf surfaces in shaded areas of vine, fruit may crack and fail to ripen. If fruit stem is infected, berries drop. Spray thoroughly just after bloom (late June or early July) and repeat during the first week of August or when mildew appears; further applications may be needed. Do not spray sulfur on sulfur-sensitive varieties such as Concord, Foch, Ives and Van Buren. Observe the no-spray interval before harvest as stated on the product label.<br>Some varieties are more susceptible to downy and powdery mildew than others. Especially susceptible to these diseases are the Agawam, Buffalo, Concord, DeChaunac, Fredonia, Foch, New York Muscat and Seneca varieties. Other varieties should be planted to avoid the need for fungicides. Also, select a location exposed to sun and wind. | benomyl**<br>folpet<br>sulfur |
| | **Poor fruit set** is sometimes attributed to insects and diseases. Although mildew does attack flower or fruit clusters, other conditions may be the cause of poor fruit set, namely, poor pollination, too much fertilizer and improper pruning which results in excessive vegetative growth. | |
| **RASPBERRY**<br>*(Figure 56, page 92)* | **Anthracnose** mainly affects the canes, causing numerous gray spots with purple borders. Later the bark may crack. If severe, it may affect branches, fruit stems and leaves. Immature fruit dries up, while ripe berries may become soft and misshapen. For treatment see below. | |
| *(Figure 57, page 92)* | **Spur blight** is most serious on the lower part of first-year canes where purplish-brown areas appear around joints of leaf stems and canes. On second-year canes, diseased areas are gray with small black pimples. Diseased canes are weakened and may be killed during winter. | |

*(Continued on page 36)*

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**Only available in multipurpose mixtures (see pages 5, 80).*

***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **RASPBERRY** | To control **anthracnose** and **spur blight:** As soon as harvest is completed, cut at ground level all old canes and those young canes which show severe disease symptoms. Also, thin remaining canes to about 15 cm apart and the row to not more than 30 to 50 cm wide. Discard all cut canes with the garbage or burn them. Keep rows free from weeds, as good air circulation is important. Spray lime sulfur when leaf buds are breaking in spring and again when leaflets are 1/2 to 1 cm long. Then spray captan when the new shoots are 15 to 20 cm tall, again when they are 30 to 40 cm tall, and repeat 2 weeks later. Spray thoroughly. | lime sulfur<br>captan |
| *(Figure 1, page 82)* | **Aphids** sometimes infest raspberry plants. Spray if these insects are abundant, but not during bloom. Observe the no-spray interval before harvest as stated on the product label. | insecticidal soap<br>malathion |
| *(Figure 25, page 86)* | In June and July, **cane borer** beetles fly from wild or neglected raspberries or from roses to attack cultivated raspberries. The female is a black-and-yellow longhorned beetle with two black dots on a yellow thorax. It cuts a double row of punctures about 1.25 cm apart around the raspberry stem near the tip and lays an egg between the girdles. The tip wilts and the grub bores down the cane about 5 cm where it hibernates. The following season it continues downward and pupates inside the burrow. The cane dies. Cut out and destroy wilting tips as soon as they appear. Make the cut about 15 cm below the girdles. Cut out wilted or dead fruiting canes. Eradicate wild and neglected raspberries in the immediate vicinity. | |
| | **Raspberry Crown borers** are 2.5 cm long, cream-colored larvae with brown heads. They damage canes by burrowing at the base of the cane, in the roots and in the crown. Affected canes wither and die, or growth is limited and fruit is small. | |
| | A slight infestation (less than 5%) may be treated fall and spring for 2 years with a drench to the crown area. Remove any neighboring wild raspberry canes. | diazinon |
| | A more severe infestation should be removed in late September to early October. Burn affected canes, including large roots, and plow under the soil. | |
| | **Fruitworms** damage raspberry plants in several ways. The 4 mm brown beetles skeletonize young unfolding leaves, destroy blossom clusters and eat holes in blossom buds. Small 6 mm larvae feed inside flower buds and in developing fruit. If this insect has been a problem in past years or if injury by beetles is noticed, spray or dust just before bloom. To protect bees, do not apply malathion during bloom. | malathion<br>rotenone |
| | **Fruit rot** may be a problem if rainy weather prevails between blossoming and harvest. Spray during this period if fruit rot was a problem in previous years and weather is wet. Repeat at about 10-day intervals. Observe no-spray interval before harvest as stated on the product. | benomyl**<br>captan |
| | **Powdery mildew** may occur during hot, humid weather. It causes stunting of young canes and is visible as a white fungus growth on leaves. Spray when noticed and repeat weekly until symptoms disappear. | benomyl** |
| | **Rust Diseases** Three rust diseases commonly affect raspberries and blackberries: yellow rust and late yellow rust occur on red raspberries; late yellow rust on purple raspberries; and orange rust on blackberries. | |

*(Continued on page 37*

***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **RASPBERRY** (continued) | Symptoms of yellow rust and late yellow rust are the development of clumps of orange-yellow spores on the undersurface of leaves, and occasionally on the fruit. Affected leaves turn yellow, develop brown areas, and may drop prematurely. Severe premature leaf drop will predispose canes to winter injury. Yellow rust can also infect canes. Overwintering cane lesions become cankerous, and infected fruiting canes may break or dry the following summer. Yellow rust and late yellow rust fungi overwinter in infected tissues.<br>Blackberries infected with orange rust develop upright, spindly shoots. In the spring, a yellow, glandular coating develops on the undersurface of developing leaflets. This coating later breaks open to reveal bright orange spores, which are the means by which the disease is spread. Affected leaves are dwarfed and misshapen. Orange rust overwinters in the canes, crowns and roots of diseased plants. As the disease is systemic, diseased plants do not recover. Affected plants should be dug up and removed when noticed.<br>Yellow rust and late yellow rust, generally are of minor importance in Ontario, causing problems only in years having cool, humid weather, and late spring rains. Remove and discard infected canes and foliage in fall or early spring to reduce overwintering inoculum. | |
| | Where susceptible varieties are severely attacked, apply dormant application of lime sulfur. | lime sulfur |
| *(Figure 24, page 86)* | The larvae of the **raspberry sawfly** are pale green and about 1 cm long when full grown. It is difficult to see the larvae but the large irregular holes in the leaves are typical for this insect. The damage to the plants is usually not harmful. Treat foliage if new cane growth is severely damaged. | insecticidal soap<br>rotenone |
| *(Figure 38, page 88)* | **Sap beetles,** also called **picnic beetles,** are black with cream markings. They enter the berries when almost ripe and may invade boxes of picked berries. Usually, they are present in large numbers, making it very difficult to remove them by hand. Remove picked fruit from the planting promptly. These insects also attack tomatoes and sweet corn. | |
| | Commercially prepared bait is available. | carbaryl (bait) |
| | Homemade solid or liquid bait can be used for control. Place open containers with bait consisting of mashed bananas, ripe melon, or chopped immature sweet corn in several places between raspberry plantings; renew bait regularly and destroy beetles with old bait.<br>Apple cider vinegar or a yeast-sugar-water mixture are excellent homemade baits. By adding a few drops of liquid dish detergent the beetles will be drowned in this liquid bait. | |
| **STRAWBERRY** | **Fruit rot,** also called **gray mold,** is common during wet weather between blossoming and harvest; berries rot when almost ripe, although green fruit may also be infected. This disease is difficult to control when established; prevention is more effective. Protect blossoms from frost injury with a straw mulch. Start spraying just before first blossoms open, and repeat at weekly intervals. Benomyl may be applied until the end of the harvest. *Caution: do not apply captan later than the end of the blossoming period.* If necessary, water thoroughly in the morning to allow plants time to dry before evening. | benomyl**<br>captan |

***See "Resistance to benomyl" on page 27.*

# CONTROL OF INSECTS AND DISEASES ON FRUIT

| Kind of Fruit | Descriptions and Treatments | Use One of these Pesticides if Necessary |
|---|---|---|
| **STRAWBERRY** | **Leaf spot** disease causes red-purple spots on leaves of first- and second-year plants. Spots enlarge and centres become gray. If spots are numerous, leaves may be killed, and yield reduced. When planting, trim off diseased leaves. Spray 1 month later and repeat twice at 14-day intervals. | captan |
| *(Figures 32(a), (b), page 87)* | **Plant bugs** pierce developing fruit and suck the sap, causing small deformed berries. If there has been a problem in the past, spray just before blossoms open and again about 10 days later. If many blossoms have opened, spray during late evening to avoid killing bees. See pages 58 for further description. | dimethoate |
| | **Strawberry clipper weevils** are destructive, 2-3 mm, reddish snout beetles. They cut the stems of blossom buds, causing them to wilt and drop off or to hang by a thread. Observe strawberry buds closely, and spray when first clipped buds are noticed. If many blossoms have opened, spray in the evening to avoid killing bees. | methoxychlor |
| | **Strawberry leafrollers** are small, greenish or bronze, 1.25 cm long, caterpillars that fold or roll the leaflets with fine silken threads. Overwintering as pupa, small grayish or brown moths emerge in mid-to late May to lay eggs on the undersurface of the leaves. The larvae migrate to the upper leaf surface when half-grown, roll the leaves for protection and continue feeding. A second generation occurs in mid-August.<br>If infection is minor, remove affected leaves and destroy. If this pest has caused severe damage in the past, apply insecticide using sufficient water to thoroughly wet plants during the first or second week of June and again during the third week of August. | |
| | **Red Stele** is a common root rot disease causing the inner roots to turn rusty red. Such roots function poorly and berries from infected plants are small though not deformed. Where this disease is a problem, obtain certified young plants with cream-colored roots every year and harvest during the following year only. Since this is primarily a disease of older plants, remove old plantings after harvest.<br>Where space permits, planting in a different location is advisable. There is no chemical control. | |
| | **Black root rot** is another soil-borne disease causing roots of old plants to turn dark brown. There is no chemical control. Using certified plants will reduce the likelihood of bringing these root diseases as well as viruses into the garden. | |
| *(Figures 5 and 10, pages 82 and 83)* | **White grubs** and **wireworms** may cause extensive damage to new strawberry plantings. For description of these insects, see page 60. If the area to be planted is in grass sod, till or dig the soil before mid-May and delay planting until the following year. During the fallow year, cultivate the area regularly, or plant the area with a crucifer crop or snap beans, since the roots of these plants are not favored by white grubs or wireworms. | |

# SPRAY PROGRAM FOR APPLE AND PEAR

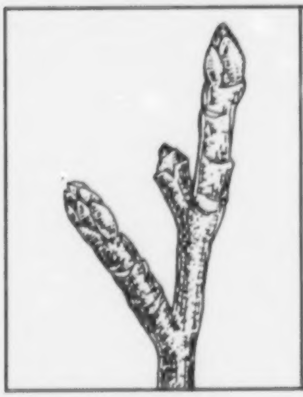
| TIME TO SPRAY | PESTS TO CONTROL | PESTICIDES TO USE | REMARKS |
|---|---|---|---|
| **Dormant stage (before buds break)** *(Figure A, page 40)* | **Scale insects** | Use one of:<br>**dormant oil spray** | Apply dormant oil in the morning to allow thorough drying before a cold night. Dormant oil may injure the bark of Red Delicious apple and may enlarge lenticels of pear bark on young twigs.<br>Apply dormant sprays in spring before buds break; use sufficient spray mixture to wet all twigs and bugs thoroughly; spray from all sides of tree. |
| | **Pear scab on Flemish Beauty Pear** | **dormant lime sulfur spray** | Lime sulfur in this season eliminates pear scab fungus overwintering on twigs (e.g., on Flemish Beauty and Sheldon). If pear scab is not a serious problem, omit dormant application for scab. |
| **Half-Inch Green Stage** *(Figure B, page 40)* | **Mites** | **dormant oil spray** | Oil controls European red mite eggs but not two-spotted spider mite. *Caution: If dormant oil was applied for scale, do not use it for mite control.* |
| **When buds break** *(Figure B, page 40)* **until open flower bud cluster** | **Apple scab,**<br>**Pear scab** | Use one of:<br>**benomyl****<br>**captan**<br>**ferbam***<br>**sulfur** | Sprays may be required weekly during this time if prolonged wet periods occur.<br>Do not apply captan if dormant oil spray was applied.<br>Do not use benomyl on pear. |
| **From pink flower buds until first open blossoms** *(Figure C, page 40)* | **Apple scab,**<br>**Pear scab** | Same as above | |
| | **Caterpillars**<br>**Pear psylla** | Add one of:<br>**carbaryl**<br>**diazinon**<br>**insecticidal soap**<br>**methoxychlor**<br>**permethrin**<br>**phosalone*** | Never use insecticides when blossoms open or dandelions are in bloom under fruit trees.<br>If aphids become a problem, use either diazinon or phosalone.<br>Insecticidal soap is registered for use against pear psylla and pear slug only.<br>Do not use methoxychlor for pear psylla. |
| | DO NOT APPLY INSECTICIDES OR MULTIPURPOSE MIXTURES DURING BLOSSOM PERIOD | | A spray of captan or benomyl may be applied for scab if necessary. Do not use benomyl on pear. |
| **When flower petals fall** *(Figure D, page 40)* | **Apple scab,**<br>**Pear scab** | Use one of:<br>**benomyl****<br>**captan**<br>**ferbam***<br>**sulfur** | Do not use benomyl on pear. |
| | **Mites**<br>**Pear psylla**<br>**Plum curculio**<br>**Plant bugs** | Add one of:<br>**diazinon**<br>**dicofol***<br>**dimethoate**<br>**insecticidal soap**<br>**permethrin**<br>**phosalone*** | To avoid thinning of apples (not pears), do not apply carbaryl at this time.<br>If mites have been a serious problem, use dimethoate, phosalone or a mixture containing dicofol.<br>Insecticidal soap is for use on pears for pear psylla and pear slug control only. |

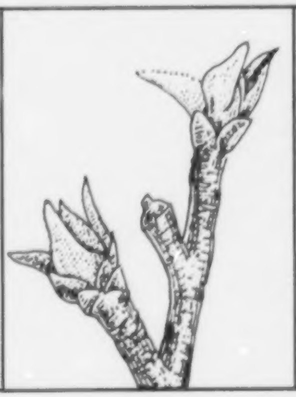
**Only available in multipurpose mixtures (see pages 5, 80)*
***See "Resistance to benomyl" on page 27.*

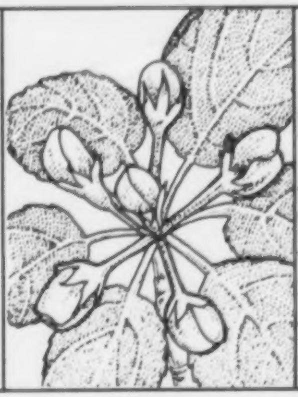
# SPRAY PROGRAM FOR APPLE AND PEAR

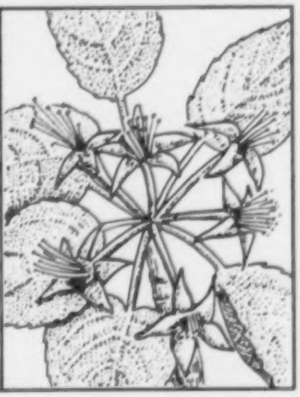
| TIME TO SPRAY | PESTS TO CONTROL | PESTICIDES TO USE | REMARKS |
|---|---|---|---|
| **12 days after petals fall and repeat at 12- to 14-day intervals until about mid-August** *(Figure D, page 40)* | **Scab** | Use one of:<br>**benomyl****<br>**captan**<br>**ferbam***<br>**sulfur** | *Observe no-spray interval before harvest as stated on product label.*<br>Do not use benomyl on pear. |
| | **Pear psylla**<br>**curculio**<br>**Apple maggot**<br>**Codling moth** | Add one of:<br>**carbaryl**<br>**diazinon**<br>**dimethoate**<br>**insecticidal soap**<br>**permethrin**<br>**phosalone*** | Unless fruit set on apple is very heavy, do not use carbaryl insecticide within 3 weeks after petals fall.<br>Insecticidal soap is registered for use against pear psylla and pear slug only.<br>Apple maggot is very difficult to control if unsprayed apple, crab apple, prune, quince, or hawthorn trees grow nearby. |

**Only available in multipurpose mixtures (see pages 5, 80).*
***See "Resistance to benomyl" on page 27.*


**DORMANT**
**Figure A***


**HALF-INCH GREEN**
**Figure B**


**PINK**
**Figure C**


**PETAL FALL**
**Figure D**

**With permission of the Michigan Cooperative Extension Service.*

# SPRAY PROGRAM FOR APRICOT, CHERRY, NECTARINE, PEACH AND PLUM

| TIME TO SPRAY | PESTS TO CONTROL | PESTICIDES TO USE | REMARKS |
|---|---|---|---|
| **Dormant stage (before buds break)** *(Figure A, page 40)* | **Scale insects** | Use one of:<br>**dormant oil spray**<br>**dormant lime sulfur** | Spray dormant oil in the morning to allow thorough drying before a cold night.<br>Use dormant strength. |
| | **Peach leaf curl** | Use one of:<br>**lime sulfur**<br>**ferbam** | For peach and nectarine trees, one peach leaf curl spray is usually needed every year. |
| | **Plum black knot** | **lime sulfur** | Delay spray until buds are about to burst. Injury will occur if too late or if spray dries slowly. Cutting out the knots is the important control (page 33). The lime sulfur will not prevent an outbreak of mites. |
| **Half-Inch Green Stage** *(Figure B, page 40)* | **Mites** | **dormant oil spray** | Oil controls European red mite eggs but not two-spotted spider mite.<br>*Caution: If dormant oil was applied for scale, do not use it for mite control.* |
| **When flower petals fall** *(Figure D, page 40)* | **Plum leaf spot**<br>**Cherry leaf spot** | Use one of:<br>**benomyl****<br>**captan**<br>**ferbam***<br>**sulfur** | Spray immediately when petals start to fall.<br>If leaf spot has been serious on plum and cherry, use captan or ferbam. Leaf spot fungus does not affect peach and nectarine.<br>Do not use sulfur on cherry. |
| | **Plum curculio on plum, cherry, peach** | Add one of:<br>**carbaryl**<br>**diazinon**<br>**permethrin**<br>**phosalone*** | Time to spray as above.<br>These may be combined with fungicides above.<br>If plum curculio is not a problem, omit the insecticide.<br>Plum curculio injury may increase brown rot of stone fruit. |
| **10 days later** | **Plum leaf spot**<br>**Cherry leaf spot** | Same as above | |
| | **Plum curcalio** | Same as above | |
| **July 1-10** | **Leaf spot**<br>**Brown rot** | Use one of:<br>**benomyl****<br>**captan**<br>**ferbam***<br>**sulfur** | Dates for this and following sprays are only approximate, depending on geographic location and season.<br>Do not use sulfur on cherry. |
| | **Cherry maggot**<br>**Fruit moth**<br>**Worms in peach** | Use one of:<br>**carbaryl**<br>**diazinon**<br>**dimethoate**<br>**permethrin**<br>**phosalone*** | Where cherry maggot has been a problem in the previous year, also spray 10 days earlier (June 20-30).<br>Do not use diazinon on peach.<br>Dimethoate may only be used on sweet and sour cherries. |

**Only available in multipurpose mixtures (see pages 5, 80).*
***See "Resistance to benomyl" on page 27.*

# SPRAY PROGRAM FOR APRICOT, CHERRY, NECTARINE, PEACH AND PLUM

| TIME TO SPRAY | PESTS TO CONTROL | PESTICIDES TO USE | REMARKS |
|---|---|---|---|
| July 15-30 | **Leaf spot**<br>**Brown rot** | Same as on page 41 | *Observe no-spray interval before harvest as stated on the product label.* |
| | **Worms in peach**<br>**Maggots in prune**<br>**Mites** | Same as on page 41 | Check foliage at this time for mite injury (see page 28). |
| Later sprays | **Leaf spot**<br>**Brown rot** | Same as on page 41 | *Observe no-spray interval before harvest as stated on the product label.*<br>On cherry, apply only fungicide for leaf spot after harvest.<br>Plums and peaches may require an extra spray for brown rot before harvest. |
| | **Worms in peach** | Same as on page 41 | Late peaches may require an insecticide about 4 weeks before picking. |

# KEY TO POSSIBLE CAUSES FOR PLANT PROBLEMS ON ORNAMENTAL PLANTS (FLOWERS, SHRUBS AND TREES)

**The following key is designed to help you narrow down the possible causes of your plant problems. Observe the symptoms on the injured portion of the tree, shrub or herbaceous plant and then refer to the corresponding section of the table. Several possible causes may result in similar visual symptoms. Refer to the appropriate page numbers for more detailed descriptions of some of the more common problems. When in doubt about your diagnosis, consult a qualified specialist before attempting control treatments.**

| Symptoms | Possible Causes | Example in this Publication (page) |
|---|---|---|
| I. PROBLEMS ON SEEDLINGS AND TRANSPLANTS | | |
| A. Seedlings don't emerge from soil; or if emerged, are stunted or wilt early | — seed too old, or not stored properly, lost viability | |
| | — improper soil temperature (usually too cold) | 11,12 |
| | — improper soil moisture (waterlogged or dry soil) | 12 |
| | — improper planting depth (too deep; or some seeds need light to germinate) | |
| | — damping-off fungi | 12,63,66 |
| | — improper soil preparation (compacted soil, surface crusting) | 48 |
| | — insect feeding (seed corn maggots, wireworms, etc.) | 18,22,60 |
| | — preemergence herbicides used (these are germination and root inhibitors) | 49 |
| | — excessive fertilizer salts near plants | 48,49 |
| | — seed-borne fungal or bacterial disease (eg., *Alternaria* blight of zinnia) | 65 |
| B. Seedlings grow, but either disappear, are cut off near the ground, or are badly chewed | — birds feeding on seed or seedling | |
| | — slugs or snails | 59 |
| | — cutworms | 55 |
| | — earwigs | 55 |
| | — meadow mice, chipmunks, groundhogs, rabbits | 74 |
| | — sowbugs or pill bugs | 13,60 |
| C. Transplants don't grow, develop dead areas on leaves, wilt, or die | — over-fertilization | 49 |
| | — stems or roots damaged during transplanting or handling | |
| | — improper soil moisture (too wet or dry) | 48 |
| | — diseased transplants (e.g., *Rhizoctonia* on marigold, *Alternaria* blight of zinnia) | 63,66 |
| | — damping-off and root rot fungi | 63,66 |
| | — insect injury (eg., white grubs, wireworms) | 60 |
| | — planted too deeply | |
| | — initial transplant shock | |
| | — cold temperature or frost | 48 |
| II. PROBLEMS ON PLANTS WHICH GROW AND HAVE BECOME ESTABLISHED | | |
| **A. Problems on leaves and/or needles** | | |
| 1. Leaves and/or stems have dead spots, variable size, shape, and color | — fungus leaf spot, blight, or anthracnose, *Botrytis*, white mold | 64,65,62,67 |
| | — bacterial leaf spot or blight | 65 |
| | — injury from contact-type weed killers applied nearby | 49 |
| | — black spot of rose | 62 |

*(Continued on page 44)*

| Symptoms | Possible Causes | Example in this Publication (page) |
|---|---|---|
| 2. Leaves have brown, scorched margins and areas between veins | — severe temperature changes<br>— improper soil moisture (too wet or dry)<br>— over-fertilization<br>— root rot disease<br>— mechanical injury to roots or stem<br>— root damage from insects or nematodes<br>— feeding damage by mites or insects (such as leafhoppers or thrips)<br>— physiological leaf scorch<br>— herbicide injury<br>— salt injury | 65<br>48<br>49<br>66<br><br>49,52,60<br>56,60<br>65<br>49<br>48 |
| 3. Leaves deformed (distorted, tattered, twisted, puckered, cupped) | — lawn weed-killer (herbicide injury)<br>— virus disease<br>— frost injury<br>— improper budbreak<br>— insect infestation (eg., aphids, leafhoppers, plant bugs)<br>— severe wind injury | 49<br>14,50<br>48<br>48<br>56,58<br>49 |
| 4. Leaves with abnormal growths of various shapes and colors (warts, pimples, galls, felt-like patches, swollen, curled areas) | — leaf curl or blister fungi (peach, oak, poplar, etc.)<br>— gall-forming insects, mites, or other organisms<br>— oedema (tan blistering) | 32<br>55<br>65 |
| 5. Leaves have dead, hollowed out areas, granular material and/or insect larva found inside | — leafmining insects (eg., birch or cedar leafminers) | 51,54,57 |
| 6. Leaves have small portions partially eaten<br>(a) lace-like 'skeleton' of veins remaining<br>(b) small notches chewed out of leaf margins | — leaf skeletonizer insects (eg., pear or rose slug, elm and willow leaf beetle)<br>— feeding injury by young or small insects (caterpillars, beetles, etc.)<br>— black-vine weevil; Taxus weevil | 55,57<br>55,58<br>52 |
| 7. Leaves with large portions completely missing:<br>(a) ragged appearance of remaining leaf tissue<br>(b) large circular holes cleanly cut out | — insect injury (eg., caterpillars, cutworms, grasshoppers, etc.)<br>— slug or snail injury<br>— vertebrate pest injury (groundhogs, rabbits, deer, etc.)<br>— severe wind injury, hail<br>— leaf cutter bees or ants | 52,55,56<br>59<br>74,75<br>49<br>56 |
| 8. Leaves and branches with sticky deposit, sometimes sooty and black | — honeydew from sucking insects feeding (aphids, mealybug, scale, whitefly)<br>— sooty mold growth on the honeydew | 51,58,60<br>67 |
| 9. Leaves with abnormal color<br>(a) yellowing (chlorosis) | — improper pH<br>— nutrient deficiency<br>— improper soil moisture<br>— root rot disease<br>— nematode infestation of roots<br>— over-fertilization<br>— herbicide injury from residues in soil<br>— wilt disease (bacterial or fungal)<br>— autumn shed of conifers | <br><br>48<br>66<br>49<br>49<br>49<br>68<br>61 |

*(Continued on page 45)*

| Symptoms | Possible Causes | Example in this Publication (page) |
|---|---|---|
| (b) bleached, bronzed, or glazed | — chilling injury | 48 |
| | — sunscald | |
| | — desiccation by strong winds | 49 |
| | — air pollution injury | 48 |
| | — mite, thrips, or lacebug feeding | 56,57,60 |
| | — dog injury | 64 |
| (c) red or purple | — nutrient deficiency (usually phosphorus) | |
| | — high soil pH (alkaline) | |
| | — cold temperature stress | |
| | — poor root growth | 48 |
| | — needle cast of spruce | 65 |
| (d) mottled yellow and green | — virus infection | 14,50 |
| | — fungus disease | 49 |
| | — foliar insect feeding (plant bugs, leafhoppers, etc.) | 56,58 |
| | — mycoplasma-like organism infection (aster yellows) | 61 |
| (e) premature fall coloring | — unfavorable soil conditions | 48 |
| | — damaged root systems | 66 |
| | — trees in state of decline | 64 |
| 10. Leaves with mold growth | | |
| (a) olive-green, black, dark brown patches | — scab | 67 |
| (b) sticky black mold | — sooty mold | 67 |
| (c) grayish-brown mold | — Botrytis | 62 |
| (d) white, fluffy mold | — white mold | 67 |
| (e) white, powdery mold | — powdery mildew | 66 |
| (f) rusty red, orange blisters | — rust | 66 |
| (g) shiny black blotches | — tar spot | 67 |
| 11. Leaves with fine webbing | — mites | 57 |
| **B. Problems on stem or trunk** | | |
| 1. Branches or trunk with sunken areas of dead bark, or with bark missing or cracking | — cankers caused by fungi or bacteria | 62 |
| | — cankers caused by winter injury | 48 |
| | — cankers caused by lightning strikes | |
| | — vertebrate pest injury (squirrels, porcupines, meadow mice, etc.) | 74,75 |
| | — vandalism | |
| | — wounds from lawn mowers, tool, hail, vehicles, snow removal | 48 |
| 2. Branches or trunk with gum, resin, or sawdust-like frass emerging from bark, sometimes with holes present, or upraised ridging on the bark | — wood-boring insects | 52 |
| | — canker fungi or bacteria | 62 |
| | — mechanical wound | 48 |
| | — winter injury | 48 |
| 3. Bark with swellings | — crown gall (forsythia, rose, etc.) | 63 |
| | — cedar apple or quince rust on juniper | 63 |
| | — fungus gall (eg., black knot on Prunus) | 33 |
| | — plant reaction to feeding or egg laying by insects | 55,56 |
| 4. Branches, twigs, or leaves with bumps which easily scrape off | — scale insects | 58 |
| 5. Branches and leaves rolled up or covered with silk webbing, containing granular frass | — tent caterpillars | 53 |
| | — fall webworm | 53 |
| | — ugly nest caterpillar | 53 |
| | — leafroller caterpillars | 54 |
| | — web spinning sawflies | 54 |

*(Continued on page 46)*

| Symptoms | Possible Causes | Example in this Publication (page) |
|---|---|---|
| 6. Branches, stem, or trunk which, when cut off, show discoloration or decay | | |
| (a) outer sapwood or cambium discolored in a woody plant | — wilt disease (*Verticillium*, *Fusarium*, Dutch elm disease) | 64,68 |
| (b) inner wood discolored or decaying; sometimes bracket, shelf-like fungi or mushrooms present on bark or on the ground nearby | — fire blight, bacterial blight | 64,68 |
| | — wood decay fungus | 69 |
| | — inner darkening of young branches by winter injury | 48 |
| (c) vascular (sap and water conducting portions) tissue discolored of herbaceous plants | — Armillaria root rot | 66 |
| | — bacterial wilt disease (eg., geranium wilt) | 68 |
| | — fungal wilt disease (*Verticillium, Fusarium)* | 68 |
| 7. Branches dieback from tips, youngest growth mainly affected, random pattern on the plant | — shoot-boring insects | 52 |
| | — tip blight fungus disease | 64 |
| | — bacterial blight disease | 68 |
| | — winter injury | 48 |
| **C. Problems on entire plant, or a large section of the plant** | | |
| 1. Plants wilt partially, or totally, or suddenly die | — over-fertilization | 49 |
| | — severe drought | |
| | — black walnut trees nearby | 67 |
| | — insects boring or tunneling in stem (eg., borers) | 52 |
| | — wilt or canker fungi or bacteria attacking roots and stem (eg., white mold, bacterial wilt, etc.) | 62,67 |
| | — root rot disease | 66 |
| | — girdling of roots (twine, wire, etc.) | |
| | — winter injury | 48 |
| 2. Entire plant growing slowly; isolated parts dying; dieback, discoloration, or premature fall color development | — root gall disease | 63 |
| | — decline disease (birch dieback, ash and maple decline) | 62,64 |
| | — girdling of roots (twine, wire, etc.) | |
| | — root rot disease | 66 |
| | — winter injury | 48 |
| | — cankers or borers girdling the trunk or stem | 52 |
| | — nematode infestation | 49 |
| | — improper soil moisture | 48 |
| | — improper use of herbicides nearby | 48 |
| | — salt injury | |
| **D. Problems on roots or tubers** | | |
| 1. Plant pulls out easily, roots discolored, outer root (cortex) may easily pull away from inner root (stele) | — root rot fungi | 66 |
| | — excess soil moisture | 48 |
| | — root-feeding insects | 60 |
| | — nematode infestation | 49 |
| 2. Swellings on roots, variable size, soft or woody | — crown gall | 63 |
| | — root knot or cyst nematodes | 49 |
| | — normal root nodules on leguminous plants (pea family) | |
| 3. Tunnels or channels eaten in the root or on root surface | — insect injury (black vine or Taxus weevil, white grubs) | 52,60 |
| | — rodents | 74 |

*(Continued on page 47)*

| Symptoms | Possible Causes | Example in this Publication (page) |
|---|---|---|
| 4. Roots mushy, with distinct odor | — bacterial soft rot | 61 |
| **E. Problems on buds and young shoots** | | |
| 1. Buds don't grow in spring, dead, dry, or discolored inside | — winter injury | 48 |
| | — severe stress during previous growing year causing poor bud set | 48 |
| | — salt spray from nearby road | 48 |
| 2. Buds grow, but are bunchy, malformed, swollen | — insect or mite injury (aphid, galls, etc.) | 51,55 |
| | — virus or mycoplasma disease | 14,50 |
| | — herbicide injury | 49 |
| 3. Buds grow and begin to elongate, but shoots wilt and die soon afterwards | — winter injury (delayed effect) | 48 |
| | — fungal or bacterial blight disease | 64,68 |
| | — shoot-boring insects | 52 |
| | — frost injury | 48 |
| | — girdling by rabbits and rodents | 74 |
| **F. Problems on flowers** | | |
| 1. Flowers do not appear | — flower buds not produced the previous year | 27 |
| | — plant parts bearing flower buds removed by pruning | |
| | — winter kill or frost injury to flower buds | 27,48 |
| 2. Flowers appear but die without producing fruit | — winter injury (delayed effect) | 48 |
| | — fungal or bacterial disease (Botrytis, leaf spots, fire blight) | 62,64,65 |
| | — frost injury or cold weather | 48 |
| | — poor pollination | 27 |
| 3. Flowers malformed | — aphid injury | 51 |
| | — plant bug injury | 58 |
| | — thrips injury | 60 |
| | — virus disease | 14 |
| | — aster yellows | 61 |
| 4. Flowers with insects feeding inside or on petals | — aphids | 51 |
| | — corn rootworm beetles, earwigs, grasshoppers | 55,56 |
| | — rose chafer, Japanese beetle | 58 |
| | — slugs or snails | 59 |
| | — thrips | 60 |

# INSECT AND DISEASE CONTROL ON ORNAMENTAL PLANTS (FLOWERS, SHRUBS AND TREES)

## Physiogenic Diseases or Injuries

Physiogenic diseases are those not caused by a living organism or virus. They principally affect the foliage and/or proper functioning of root systems. In the latter case, a gradual dieback and even an eventual mortality can occur. Physiogenic diseases are the base causes of vast numbers of plant problems, often predisposing plants to infection by secondary disease organisms. Such disorders and diseases are commonly caused by weather conditions, soil conditions, and man-made physical and chemical disturbances to the air and soil environments.

A common example is leaf and root scorch caused by high levels of salt in the soil, the result of salty irrigation water or from salt applied to remove snow and ice. A late spring leaf scorch of maple and beech has been attributed to sudden exposure of leaves to full sunlight following a wet, cloudy period.

The response to changes in the rooting environment varies with the age and kind of plant, and the nature and intensity of these changes. Oak, maple, ash and spruce are particularly sensitive, and have a low capacity to adjust to new conditions, such as soil compaction, drought, excessive water, change in soil level, root damage during construction, etc.

Control measures for physiogenic diseases primarily depend on eliminating or avoiding the damaging factors, (as in salt injury), obtaining resistant plant material, or otherwise improving the growing conditions.

Common non-parasitic injuries, resembling symptoms of disease are:

**Air Pollution,** particularly sulfur dioxide and ozone, damages some plant species more than others and is more severe in some areas of Ontario than in others.

### Winter Injury

Despite the apparent dormant state of deciduous trees and shrubs, broadleaved evergreens and conifers during the winter months, the basic plant functions of respiration and transpiration continue. Symptoms of winter injury are varied. Broadleaved and coniferous evergreens are susceptible to desiccation if planted in wind swept, exposed areas. Buds, leaves, needles, small branches become brown and die. In foundation plantings, water well late in the fall, use thick mulch on the soil surface to insulate the root system, and use protective screens of burlap to reduce exposure.

Frost cracks or "southwest injury", appear as longitudinal splits and cracking of the bark mainly on the south or west side of the trunk. Young, thin-barked trees such as **maples, linden, London plane** and **flowering cherry** are particularly susceptible. Wrapping the trunks with burlap or painting with white latex paint will reduce this problem.

Many ornamental trees and shrubs may only be marginally hardy to your area. Extreme low temperatures or rapid fluctuations during late winter will result in death of leaf and/or flower buds, with the flower buds being more sensitive. Avoid over-fertilization of plants to prevent late fall growth and ensure adequate hardening off. The effects may be delayed, not becoming evident until late spring when the new growth collapses. Sectioning through branches or twigs will show a blackening of the wood tissue throughout the core or heart of the branch.

### Frost or Chilling Injury

The blackening of young leaves and stems of **Impatiens** or **begonias** or the bronzing or bleaching of the upper leaf tissue of **cucumber** or **tomato** are typical chilling injury symptoms on annuals. Poorly hardened off transplants are particularly susceptible.

Leaf crinkling, blackened leaf margins are typical of frost injury on deciduous plants. Injury is caused by freezing temperatures after growth has begun. Despite this injury, additional growth will occur on affected branches. Flower buds of early flowering shrubs may fail to open or appear tattered and brown along petal margins. Young shoots of coniferous trees may wilt and die.

### Salt Injury

Salt injury from salt spray caused by high speed traffic and wind occurs widely along highways and main arterial roads where de-icing salt is extensively used throughout the winter. Injury symptoms on deciduous plants include failure of flower and leaf buds to open, small misshapen leaves, tip dieback and shoot tufting (as previously dormant buds on two-year-old branches develop). On conifers, needles or branchlets turn brown, beginning at the tips. The injury shows up most dramatically in late winter/early spring. Damaged needles fall, leaving bare stems. Typically, the injury develops on that side of the tree facing the road and on that side of the road facing the prevailing wind.

Salt runoff from melting ice and snow on roads and sidewalks accumulates in the soil until levels are sufficiently high to cause damage. Symptoms resulting from the uptake of the salt by plant roots include: reduced leaf size, marginal leaf scorch, premature leaf defoliation and decline. Trees known to be sensitive include white pine, cedar (Thuja), sugar maple, linden, red and white oak, and crab apple. Austrian pine, blue spruce, Russian olive, sumac and Norway maple are more tolerant.

**Poorly drained**, waterlogged soil lacks air and causes root rot.

**Pavement or compacted soil** around trees prevents air and water from penetrating soil.

**Natural gas** leaking from a pipeline seriously harms plants.

**Wind or hail injury** can cause tattering of leaves of flowers, vegetables, trees and shrubs.

**Spraying at midday** during hot weather may injure plants.

**Fertilizer** applied improperly or too heavily may cause burning.

### Herbicide Injury

Serious injury, or even death, both to garden plants, trees and shrubs can be caused by accidental exposure to herbicides. Accidental exposure can result from direct application, spray drift, or by leaching or runoff into the root zone of the non-target plant. Due to the many types of herbicides used, many kinds of injury can develop. Herbicides such as 2,4-D mecoprop, and dicamba, are growth regulator or phenoxy herbicides, used to control broadleaved weeds. They are commonly used on turf. Typical symptoms caused by these herbicides include twisting and bending of new growth, cupping and hooking of leaves, yellowing of the veins, and witches brooming (see figures 48, 55, pages 90,91). Conifers are less susceptible to phenoxy damage. However, exposure to these herbicides can result in discoloration and needle drop. Needle and shoot deformities develop only if young, actively growing needles are exposed in the spring. Plants known to be very sensitive to the phenoxy herbicides include grape, cedar, rose, tomato, beans, Manitoba maple and Chinese elm.

Non-selective herbicides, such as paraquat, kill leaves and twigs only by direct contact. Spray droplets cause discreet brown spots similar to leaf spots caused by fungi. Glyphosate is absorbed by green tissues only but is translocated to the roots. Injury symptoms include yellowing and browning of leaves, as well as deformities of young tissues. Be aware of non-selective vegetation killers that are labelled soil sterilants. These products contain herbicides such as simazine, atrazine, amitrole or diuron. Injury symptoms include interveinal, marginal, or complete yellowing and scorching of leaves, stunting, foliar drop, and dieback.

The severity of herbicide damage is dependent upon the amount of herbicide which a plant has been exposed. A slight exposure to phenoxy herbicides may have no long-term ill effects. However, exposure to soil-borne, persistent herbicides which are active over a period of weeks, months or years, will have a more serious impact on overall plant health.

Once herbicide damage has occurred, there are few corrective measures available. Practices such as watering and fertilizing, which relieve stress, are helpful.

All herbicides if used incorrectly or carelessly can injure plants. Read the herbicide label carefully before using, and follow all instructions. Before using products labelled sterilants on driveways and patios, consider whether roots of nearby trees and shrubs are growing into the area to be treated. If so, do not use. To avoid problems caused by spray drift, do not apply sprays on windy days.

## Insects

Many kinds of insects cause injury to ornamental plants and it is not possible to discuss all of those which may be found in the garden within this publication. Only the common insect problems are mentioned.

Insects of concern to the gardener may be divided into three groups, namely:

1. Insects which can easily be seen on the plants, such as aphids, beetles, scales and caterpillars.

2. Others, such as leafhoppers, mites, thrips, cutworms, slugs and weevils, which are difficult to see, but whose damage to plants is obvious.

3. Borers and leafminers which spend most of their life inside the stems or leaves, well protected against insecticides. To be effective, chemical treatment must be made during the short period when the insects are exposed. Treatments should be applied depending on observations of damage in the previous year.

A good gardener can watch for the injury and/or insects of the first and second groups and apply chemical control only when the amount of injury is severe. Keep in mind that small numbers of beetles and caterpillars can be removed by hand, and that birds and other beneficial insects often reduce harmful insects to acceptable levels.

It is usually not necessary to spray large shade trees in the home garden. These trees can tolerate considerable insect feeding without being damaged. If defoliation occurs during successive years however, they will be weakened and controls may be necessary. When spraying large trees is required, the work should be done by a licenced pest control operator or tree maintenance service.

On young shade trees, up to 7 m high, hose-end sprayers will provide sufficient coverage. Care must be taken not to inhale the spray drift or allow it to come in contact with the skin or eyes when performing this operation. Avoid contamination of swimming pools.

## Nematodes

**Nematodes** are microscopic worms which attack plant roots (and sometimes foliage). Affected roots show many small lesions, become stubby, show swollen knots or growths, or rot due to invasion by other organisms. Upper plant portions show symptoms of drought, stress, nutrient deficiencies, and stunted growth. Nematodes thrive best in sandy soils. Soil which becomes infested with nematodes must be removed and replaced. There are no chemical controls available to homeowners.

## Diseases

Diseases can be caused by the following pathogens:

**Fungi** affecting foliage, flowers and stems. Many of these fungi are spread by spores carried by air currents.

**Fungi** affecting roots and sap stream of plants (wilt disease) or the stem of seedlings (damping-off disease). These fungi live indefinitely in the soil.

**Bacteria** affecting foliage, twigs, stems or roots.

**Viruses** and mycoplasma-like organisms cause various problems on some plants.

## Diseases and their Development

**Fungicides** prevent disease infection but are not a cure once fungi have penetrated and destroyed parts of plants. Treatment made after the infection has taken place will only protect those parts of the plant which are still unaffected, and in this manner such treatment curtails the spreading of the disease. Repeated applications may be necessary to protect the new growth. These applications also renew the fungicide deposit which may have been diluted or removed by rains. Spray applications are more resistant to dilution or removal by rains that are dust applications.

Moisture in the form of rain, dew or watering encourages fungus infection of foliage (except powdery mildew which starts and develops rapidly in warm, humid weather). Hence, disease problems are generally less severe under dry conditions. Wider spacing of plants and watering only in the morning promotes quick drying. Fungicides have to be applied more often during rainy periods than during dry weather.

Some foliage diseases, such as black spot on roses, occur annually throughout Ontario. The certainty of their occurrence makes prevention by fungicide treatments necessary. For other diseases, prevention is more difficult if they are a serious problem only in some years and in certain areas; control measures should then be taken when the first disease symptoms are noticed. Observations in the previous year are helpful in predicting the occurrence of a disease outbreak.

No chemical control of diseases caused by bacteria and viruses is possible. Dwarfed and malformed plants should be removed and destroyed promptly to prevent spreading of the disease. Virus diseases are most serious on aster (double varieties), dahlia, gladiolus, lily, marigold and phlox.

Disease control in the garden is more than a matter of applying chemicals. Regular inspection of plants and some understanding of plant diseases are required to use fungicides in the proper way. Clean-up, by burning or disposing as garbage all diseased plants or plant parts, assists greatly in reducing diseases on ornamental plants.

## Mixing Products Together

All of the recommended insecticides and fungicides, in the form of liquids or wettable powders, can be mixed together in the sprayer if needed. Captan should not be mixed with dormant oil, and lime sulfur should not be mixed with any other pesticide. First add the wettable powder to the water and stir. Then add any liquid product. However, never mix dusts together, and do not try to mix a dust with water.

## Resistance to Certain Fungicides

By using a single "systemic" fungicide, such as benomyl, thiophanate-methyl, and triforine exclusively to control a certain disease, the fungus may become resistant to this fungicide. The result is that it loses its effectiveness. By alternating a "systemic" fungicide with a recommended "non-systemic" fungicide, such as captan, chlorothalonil, cycloheximide, dinocap, folpet, mancozeb and sulfur, the development of resistance can be avoided or delayed. These "non-systemic" fungicides have less specialized ways of preventing the growth of plant pathogens, and hence are less prone to cause resistance problems.

## Rate of Application

Read the label on the pesticide container for the proper rate of application; see also the discussion on page 6.

## Recommended Pesticides

On the following pages, the recommended pesticides are listed by their common chemical name in alphabetical order, not in order of preference. The common chemical name of the active ingredient(s) of each product appears on the front panel of the label following the "guarantee". The lists of available pesticides on pages 77-81 relate the common chemical names to the corresponding products sold in Ontario.

Where "insecticidal soap" is recommended, the labelled and registered product should be used and NOT ordinary household soap or detergent as these could cause damage and may not be effective.

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **APHID**<br>*(Figure 1, page 82)* | Aphids or plant lice are small, soft-bodied insects of various colors (green, red, brown, black). Host plants are weakened by the sucking of the plant sap, usually at the tip of shoots or branches and on the underside of young expanding branches. Infested leaves often become cupped and misshapen. Aphids often leave a sticky deposit (honeydew) which encourages the development of black sooty mold. Most aphid species have successive generations per growing season. Many plants are attacked especially **birch, chrysanthemum, flowering cherry, crab apple, honeysuckle, Norway maple, linden rose, spirea, willow** and many flowering annuals. (Aphids on woody ornamentals are mainly considered to be a nuisance because populations can vary from one year to the next.)<br>If control is necessary on large trees, tree maintenance companies have suitable application equipment. Spray or dust flowering annuals and shrubs when aphids are first noticed and repeat as required. When plants are in flower apply insecticide only in the evening when bees are not present. Do not use malathion on Crimson King maple.<br>The **Honeysuckle aphid** is a 2 mm long, pale green to cream colored aphid, with a fine powdery wax covering its body. Feeding by this aphid causes stunted growth, witches brooming, and curling upwards of the pale green leaves of honeysuckle. The aphids overwinters as eggs on the twigs, hatching in the spring at bud break. Early control is recommended. Prune out infested branches well below the witches broom, before the buds begin to break in the spring. Also apply dormant oil before buds break in early spring. If susceptible varieties are severely damaged in the landscape, consider replacing them with those which are resistant. | carbaryl<br>chlorpyrifos†<br>diazinon<br>insecticidal soap†<br>malathion<br>oxydemeton-methyl*<br>permethrin<br>pirimicarb* |
| **BIRCH LEAF-MINER** | In mid-May and again in early July, small sawflies lay eggs on leaves. Larvae hatch and soon enter leaf tissue where they are protected against insecticides applied on foliage. The injury shows as large brown areas on leaves. This problem is very common throughout Ontario on **birch trees, particularly the European white birch.** Select one of the following control methods. | |
| | **1. Bark treatment**<br>When leaf buds break, paint undiluted product on bark of the trunk in a band of same width as tree diameter, to a maximum of 15 cm. Repeat 6 weeks later. Do not paint on young trees less than 5 cm thick. Do not treat same area of trunk every year as injury to the bark may occur. The results of this treatment are variable. | dimethoate |
| | **2. Foliar spray**<br>Spray the foliage when first leaves have just unfolded; repeat in the last week of June. | carbaryl<br>dimethoate<br>malathion<br>oxydemeton-methyl* |
| | **3. Soil drench**<br>Apply the *undiluted* product as a soil drench in early May when the leaves start to open. Use this insecticide at the rate of 22 mL per centimetre of trunk diameter (if more than one trunk, take total of all trunks). Measure diameter at base of trunk. Pour insecticide into small shallow holes evenly divided over the area within the drip line of the tree or clump of trees. Close holes with soil. Immediately afterwards drench area thoroughly with water to saturate the soil. One treatment in May should give complete control for one season. Do not make more than one application per year. This treatment may not be effective on newly transplanted birches where the root system is not well-established. (Use foliage treatment instead.) Some hybrid varieties, e.g. cutleaf and silver birch, may be damaged by excessive amounts of dimethoate, therefore apply no more than the recommended rate. | dimethoate |

**Only available in multipurpose mixtures (see pages 5, 80).*
*†May cause injury on some plants. Read label before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **BLACK VINE WEEVIL**<br>**TAXUS WEEVIL** | This beetle feeds on edges of needles or leaves by night only and is seldom seen. The larvae feed on roots and cause plants to grow poorly and to look dry and off-color. **Azalea, euonymus, hemlock, rhododendron, yew** and **sometimes white cedar** are attacked. When injury is noticed spray trunk, lower branches and soil surface. Spray in late June and again in early July. Do not apply endosulfan on Anderson yew as needles may drop. | carbaryl (Sanex liquid Sevin)<br>endosulfan |
| **BORERS** in trunks and limbs of trees and shrubs | The larvae tunnel into wood and, in successive years, weaken and may kill the plant eventually. The injury symptoms are holes in the wood with "sawdust" underneath or gummy substance (on cherry, plum, peach). Susceptible host plants are listed below.<br>Trees and shrubs which grow vigorously are less susceptible to attack by borers. Removal of any grass sod around trunk, fertilizing and watering promote healthy growth. Wounds in the bark make it easier for the small borer larvae to enter. Avoid wounding with tools or lawn mowers. Scrape any wounds clean.<br>Young trees, especially those recently transplanted, are very susceptible to attacks by borers. Protect them by wrapping strong paper or burlap around the trunk from ground level up to lowest branch. Do not use tar paper as the fumes may be injurious. Leave wrapping in place or renew it for at least 2 years after transplanting. This method is not practical for shrubs. However, borer infested stems should be removed.<br>Thoroughly spray bark of main branches and trunk to ground level. It is very important to spray at the correct time for each kind of plant, as different species of borers are involved and young larvae have to be killed before they enter the wood. (When spraying wear long-sleeved shirt and pants; wash face and hands afterwards.)<br>**Ash, lilac, mountain ash, privet:** Spray in mid-May, repeat in late May and early June (10 days between sprays).<br>**Flowering cherry, peach and plum:** Spray in late June, repeat in mid-July and early August (3 weeks between sprays).<br>**Black locust:** Spray in mid-August, repeat in early and late September.<br>**Poplar and willow:** Spray in mid-August and again in early September.<br>**Azalea, laurel, rhododendron:** Spray about May 20 and again June 15.<br>If borers are already tunnelling in the trees, poke a flexible wire into hole, then seal with putty or similar substance. Do this in early spring and again in fall.<br>For **Bronze Birch Borer** see under Birch Dieback on page 61.<br>For **Iris Borer** see page 56. | endosulfan<br>lindane (spray)<br>chlorpyrifos† |
| **CATERPILLARS,**<br>**CANKERWORMS,**<br>**LOOPERS,**<br>**TENT CATERPILLARS,**<br>**FALL WEBWORM,**<br>**GYPSY MOTH,**<br>**LEAF ROLLERS** | Presence of these insects is obvious from the defoliation or from their "tents" or "webs" in the trees. **Birch, crab apple, flowering cherry (Prunus), hawthorn, juniper, privet, and linden** are common host plants but many others may be attacked also.<br>The presence of young stages of caterpillars which defoliate trees often goes undetected. Usually not until obvious webbing, tents, missing leaves, or dropping frass appear does an infestation become apparent. | see page 54 |

*(Continued on page 53)*

*† May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **CATERPILLARS, CANKER-WORMS, LOOPERS, TENT CATERPILLARS, FALL WEBWORM, GYPSY MOTH, LEAF ROLLERS** (Continued)<br>*(Figure 28, page 86)*<br>*(Figure 18 and 19, page 85)* | **Canker worms and loopers** are usually long, thin caterpillars that move by extending forward, and pull the hind body-portion upwards in a characteristic loop-like an "inch worm". Usually feeding in spring, infestations of these caterpillars are sporadic, and may be prevalent in one year, only to disappear for several years before again becoming a problem. Females are wingless moths, which crawl up the tree in fall or spring to lay egg masses on the bark. If trees are isolated, bands of sticky material such as Tack-Trap, Stick'em, etc. can be placed around the trunk to physically trap these female moths in spring and fall.<br>The **Eastern tent caterpillar,** spins a tent-like silken nest in branch forks in spring of **apple, flowering cherry (Prunus),** and sometimes other deciduous trees and shrubs. The tent is for shelter at night, from which the caterpillars venture out during daytime to feed. Physical removal of the tents will expose these caterpillars to predators and cold temperature. The caterpillars are black, hairy, with a white stripe down the back, brown and yellow lines and blue spots along the sides. A close relative, the **forest tent caterpillar**, is also hairy, black, but with blue and orange and pale yellow stripes on the sides, and white "foot prints" along the back. It prefers ash, birch, oak, poplar and sugar maple, but also attacks a wide variety of deciduous trees and shrubs. Its "tents" are mats on the bark of infected trees, not webs in branch forks, and thus are less obvious than those of the Eastern tent caterpillar. Both of these tent caterpillars produce brown, hard, foam-like egg collars on twigs of host trees, which can be pruned out or removed in winter or early spring before egg hatch, if accessible, to reduce infestations.<br>During periods of cold weather, tents can be broken apart in the evening, which exposes caterpillars to adverse conditions, resulting in death.<br>During periods of warm weather, twigs with tents should be pruned out and destroyed.<br>The **fall webworm** is a hairy, pale yellow caterpillar that spins large webs over branch tips of **ash, birch, boxelder, crabapple, cherry, linden, poplar, oak, walnut** and many other trees in August and September.<br>The **White-marked tussock moth**, is a red-headed, black and white tufted caterpillar which feeds on a wide variety of deciduous and coniferous trees and shrubs.<br>The **gypsy moth** is fast becoming a major pest of trees and shrubs in Ontario. The larva is a dark, hairy caterpillar having a double row of 5 pairs of blue and 6 pairs of red spots from head to tail on its back. The young emerge from overwintering, buff-colored, hairy egg masses, and move, or are blown to suitable host vegetation. They feed voraciously on nearly any woody plant except juniper, reaching up to 7 cm long before pupation in July. Because flightless female moths lay egg masses on nearly any object, new infestations can be started by movement of these eggs on vehicles, camping equipment, etc.<br>Before spring emergence, scrape gypsy moth egg masses into a container of dish detergent.<br>Trap caterpillars by tying a band of burlap around tree trunks. Inspect daily and destroy caterpillars within. This is only practical for a small number of specimen trees. | See page 54 |

*(Continued on page 54)*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **CATERPILLARS, CANKERWORMS, LOOPERS, TENT CATERPILLARS, FALL WEBWORM, GYPSY MOTH, LEAF ROLLERS** (Continued) | The **spiny elm caterpillar** is black-bodied, covered with small white flecks, large-branched spines, and a row of large red spots down the back. Preferring elm and willow, they will feed on birch, maple and several other deciduous trees, becoming obvious during mid to late spring. | |
| | Trees and shrubs can withstand considerable defoliation before growth and vigor are significantly harmed. The effects of early season defoliators, such as spring cankerworms, are often overcome by refoliation, a new burst of growth in late spring. Late season defoliators such as the fall webworm also cause little damage, because most growth, food storage, and bud production has already occurred. Successive years of defoliation, or situations when the refoliated leaves are also consumed, can lead to tree dieback and eventual death. | |
| | Thus, while considering the costly and difficult job of spraying large trees, the potential for injury should be carefully weighed. This includes environmental effects from drift of sprays as well as the ultimate effect of loss of leaves. | |
| | **Leafrollers** typically tie a leaf inwardly, feeding inside in a protected rolled up chamber. These are called leafrollers, and are controlled well only if insecticides are applied in early spring before the young caterpillars are protected from contact inside the rolled leaf.<br>Spray or dust when caterpillars or their tents are first noticed. *Bacillus thuringiensis* must be applied early in the season when caterpillars are small (0.5 cm.) For looper, treatment may have to be repeated. Do not apply endosulfan on European white birch and weeping birch as injury may occur. | *Bacillus thuringiensis*<br>carbaryl<br>diazinon<br>endosulfan<br>methoxychlor<br>oxydemeton-methyl*<br>permethrin<br>trichlorfon* |
| **SAWFLY CATERPILLAR**<br>*(Figure 36, page 88)* | These insects can cause severe damage when present in large numbers. They defoliate one branch then move to the next. June is a critical period for **larch (tamarack), mountain ash** and **pine.** On **privet**, they usually occur later. **Roses** are affected by two sawflies, one which resembles the pear slug (see page 57). The other cuts slits in a row in young shoots, inserting eggs. The shoot responds by turning black on one side and curving toward injured side. The larvae emerge and feed on foliage in groups and are green and yellow-orange with black dots. Spray or dust when noticed, and repeat as necessary. | carbaryl<br>insecticidal soap†<br>methoxychlor<br>oxydemeton-methyl*<br>permethrin |
| **CEDAR LEAFMINER** | The larvae of this insect feed inside tips of foliage causing them to turn brown. **Only the white cedar is attacked.** Adults are tiny (1 cm wide) grey moths which take flight in clouds when cedars are disturbed in June and July. | |
| | Clipping hedges and individual plants before June, and destroying the clippings reduce the insect population before adult moths emerge. | |
| | Spray in early May, repeat in late June and, if damage is severe, spray again after mid-August using this systemic insecticide, which controls larvae in, and adults on, the foliage. OR | dimethoate |
| | Spray in June and July with these contact insecticides to kill adult moths before they lay eggs. | carbaryl<br>malathion |
| | Cedars, however, can withstand considerable injury from leafminers before significant damage occurs. In most years, control will not be necessary. | |

**only available in multipurpose mixtures (see pages 5, 80).*
*†May cause injury on some plants. Read label before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **CORN ROOTWORM BEETLES** | These beetles are either light green or yellow with black stripes, about 6 mm long. They may severely damage the petals and stamens of chrysanthemums, roses and some other flowers in August and September. They may also feed on the silks of late varieties of sweet corn which reduces the number of kernels on the ear. The beetles emerge from the soil starting about the first week of August. Many gather on corn silks. After mating, the females lay clusters of eggs up to 5 cm deep in the soil at the base of corn plants. There is only one generation a year. Many beetles fly considerable distances from corn fields to feed on ornamental flowers in gardens.<br>Control by insecticides has not proven promising because beetles keep flying into the garden from corn-growing areas. Flowers intended for show competition should be bagged to keep beetles out. Cut flowers should be shaken to dislodge the beetles before they are taken indoors. | |
| **CUTWORMS**<br>*(Figure 2, page 82)* | Cutworms are smooth, soft caterpillars which feed at night on plants with soft stems. Some kinds feed below ground, others above, cutting the stem or eating foliage.<br>Bedding plants can be protected against these insects by placing cylinders made from empty cans (bottom removed) or from tar paper, partly sunken into soil, around each plant.<br>Three methods of control are available:<br>1. To prevent cutworm damage, apply on soil *before planting* and mix 5 to 8 cm deep.<br>2. Scatter bait pellets between plants or place a few pellets at the base of each plant.<br>3. If damage above ground is noticed, spray or dust on soil around stem or plant. | chlorpyrifos (dust or granular)<br>diazinon<br>carbaryl (bait)<br>carbaryl<br>chlorpyrifos (spray)†<br>trichlorfon* |
| **EARWIG** | This insect is reddish-brown and about 2 cm long with a pair of forcep-like appendages at the hind end. They are active only at night and hide by day in the soil, under stones or debris. They feed on many flowers. When many earwigs are found dust or spray the soil around plants or scatter bait pellets, preferably in June or early July. | carbaryl (bait)<br>chlorpyrifos<br>diazinon<br>insecticidal soap<br>oxydemeton-methyl* |
| **ELM AND WILLOW LEAFBEETLE** | The small adult beetles (3 to 6 mm) chew holes in leaves. Most noticeable damage is done by the black larvae, which skeletonize leaves. **American and Chinese elm, Lombardy poplar and willow are host plants.** Spray only if severe injury is noticed, usually in June. | carbaryl<br>methoxychlor |
| **GALL FORMING INSECTS AND MITES**<br>*(Figure 27, page 86)* | Many insects and mites cause **galls**, abnormal growths on plant tissue in response to their feeding, saliva, or egg-laying. These associations with certain host plants are usually not harmful, and are to be considered as biological curiosities. Hence, no control is recommended.<br>**Maple bladdergall** and **spindlegall** mites cause small bladder and spindle-shaped swellings on maple foliage. Another mite causes *crimson "erineum" galls*, felt-like, reddish patches on leaves. Mites overwinter on the bark and buds of host trees, emerging to feed in spring as buds break. As they feed | dormant oil |

*(Continued on page 56)*

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**Only available in multipurpose mixtures (see pages 5, 80).*

*†May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| **Insect** | **Descriptions and Treatments** | **Use One of these Insecticides If Necessary** |
|---|---|---|
| **GALL FORMING INSECTS AND MITES** (Continued) | on newly expanding leaves, the plant responds by producing these galls, in which the mites live and multiply throughout the growing season. Again, injury from these galls is negligible, except on young trees newly established in a stressful landscape situation. In such a case, dormant oil sprays before budbreak in early spring will reduce overwintering mites, and subsequent injury. Do not use dormant oil on Japanese or sugar maple to avoid injury. | |
| | **Honey locust pod gall midges** are tiny flies which form many small galls on young leaves of **honeylocust (Moraine, Shademaster, Sunburst, etc.)**. Honey locust pod galls are swollen, pouch-like young leaves containing orange maggots. Damage from these midge fly larvae may be unsightly, but will not harm the tree. No control is available. | no chemical control available |
| *(Figure 34, page 87)* | **Spruce gall aphid** causes formation of 2 cm long cone-like galls on **spruce**. Where possible, the cone-shaped galls should be removed and destroyed before mid-June. Spray about May 1 and repeat in mid-May. | carbaryl<br>chlorpyrifos†<br>endosulfan<br>insecticidal soap<br>malathion<br>oxydemeton-methyl* |
| **GRASS-HOPPERS** | When a lush garden is situated near weedy areas, abandoned fields, woodlots, etc., it is likely that grasshoppers may become a problem. This usually occurs when dry weather reduces the attractiveness of normal food plants, resulting in migration of grasshoppers into the garden. Young grasshoppers are much more susceptible than adults to insecticides. Alternatively, manually catch and destroy invading grasshoppers. | malathion |
| **IRIS BORER**<br>*(Figure 29, page 87)* | Feeds only in iris. Larvae feed inside leaves causing visible tunnels and "water-soaked" areas. They tunnel downward to the rhizomes (underground stems) and destroy inside. Infestation is often accompanied by bacterial soft rot (see page 61). To reduce overwintering insects, gather and destroy all old iris leaves in the fall. Divide old plants soon after flowering; while doing so remove and destroy all infested parts of rhizomes. | |
| | Spray in spring when leaves are about 12 cm tall. | dimethoate |
| **LACEBUGS** | These small bugs have scalloped, ornamental bodies which resemble lace. Their feeding causes bleached flecking and dark spots of excrement on infested foliage of **asters, chrysanthemum, ash, oak,** and other hosts. Spray these insects, often hidden under the leaves, when injury is first observed. | malathion<br>carbaryl |
| **LEAFCUTTER BEE** | The work of a leafcutter bee is usually little more than a curiosity or nuisance. The black female bee, somewhat like a small bumble bee, cuts circular discs of foliage, typically **rose, azalea, euonymous, crab apple,** plus many others to line her egg cells. The bee is solitary, nesting in hollow twigs. Control is not necessary. | |
| **LEAFHOPPER** | They are small greenish insects which jump quickly when disturbed. They suck plant sap causing a scorched or speckled appearance to the leaf. **Many annual and perennial plants are affected, especially delphinium, hollyhock, honeylocust, lupine, marigold and zinnia.** Spray or dust when leafhopper injury is noticed. Several applications may be necessary. | carbaryl<br>diazinon<br>malathion<br>methoxychlor<br>oxydemeton-methyl* |

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*†May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **LEAFMINERS** | The larvae of many flies, beetles, moths, and sawflies feed by tunnelling between outer leaf surfaces. Some of these leafminers cause blotch-shaped or serpentine tunnels that can, if infestations are severe and repeated, reduce the aesthetic value and lifespan of trees, shrubs, and herbaceous plants. Leafminers are common on **birch (see page 51), basswood, white cedar (see page 54), crabapple, columbine, lilac, elm, oak, black locust, mock orange, spruce, and other ornamentals.** With all of these pests, either of two tactics are required: | |
| | 1. Control the adults before or during egg laying to prevent larvae from achieving protection inside the plant. | carbaryl<br>malathion |
| | 2. Control the young leafminers with systemic insecticides after they have begun tunnelling. | dimethoate<br>oxydemeton-methyl* |
| | Leafminer populations vary from year to year, and may not be significant enough to warrant control. | |
| **MILLIPEDE**<br>*(Figure 3, page 82)* | These pests are dark brown worms about 3 cm long with 100 or more legs. They are usually found curled up like a coil spring. They feed on manure and decaying organic matter and do little or no harm to plants, hence they should not be controlled. The millipede is often mistaken for a wireworm, which is orange with 6 pairs of legs and can cause severe damage to roots of plants. | |
| **MITE**<br>*(Figure 31, page 87)* | Mites are very small and spider like, living mostly on underside of leaves, where they suck plant sap. When numerous, and webbing is visible, the foliage first turns a dull bronze color, later yellowish. Hot dry weather is favorable for this pest. **Crab apple, juniper, mountain ash, rose, spruce, white cedar and many flowers may be infested.** Mite population on foliage can be reduced considerably by a forceful stream of water from the garden hose, directed at underside of leaves. Repeat from time to time if mites are numerous. | |
| | If needed, use one of the following treatments:<br>1. Spray when damage indicates severe infestation. Repeat in 7 days.<br>2. Dormant oil may be applied on **juniper, spruce, and white cedar** in late April. For timing of application on deciduous trees and shrubs, see page 28. Dormant oil kills overwintering spider mite species but not other species overwintering elsewhere. Spray in the morning of a mild day so that spray dries before evening.<br>*Caution: Do not apply dormant oil on Japanese and sugar maple or on blue spruce to avoid injury.* | chlorpyrifos†<br>dicofol*<br>dinocap*<br>insecticidal soap†<br>oxydemeton-methyl*<br>dormant oil |
| **PEAR SLUG**<br>*(Figure 23, page 85)* | This larvae skeletonizes foliage of **flowering cherry, plum** *(Prunus)* **and pear**; also **hawthorn** and **cotoneaster**. It is the larva of a sawfly and is not a true slug. This slime-covered larva is first dark green, later turning to orange. It is about 1 cm long and feeds on the leaves, leaving only a framework of veins. Spray or dust when larvae are noticed. Dusting with talc or fine, dry soil also controls this insect, as it causes it to dry out. | carbaryl<br>insecticidal soap<br>malathion<br>methoxychlor<br>(Use any one of these insecticides at same rate as for other leaf-eating insects) |

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*†May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **PINE SHOOT MOTH** (also called European pine shoot moth) *(Figure 33, page 87)* | Larvae feed inside buds in May and early June. Young shoots developing at that time become deformed or are killed. The flow of resin from the bud indicates that larvae are present. **Austrian, mugho, red and Scots pines** are susceptible. If a few small trees are involved, remove infested shoots by hand in May and destroy them. If this is not practical, spray thoroughly in late April and again between June 25 and July 7. | diazinon<br>dimethoate |
| **PLANT BUGS** *(Figure 32(a), (b) page 87)* | Plant bugs cause distorted shoots and flowers, or circular, bleached spots on the leaves where they feed. A large variety of ornamentals and herbs are affected, including **chrysanthemum, marigold, zinnia, daisies, mint**. Adult tarnished plant bugs (TPB) are brown, while the four-lined plant bugs (FLPB) are greenish-yellow with four black stripes. Both are 6-7 mm long and very active, readily flying when disturbed. Young TPB are light green, while young FLPB are bright red, each with dark spots and markings. TPB may be a problem throughout the season, while FLPB is prevalent in late spring and summer. Weedy areas nearby provide food and shelter for plant bugs which migrate into the garden. Apply the insecticide when young are first noticed in the spring or when migrating adults appear. | carbaryl<br>malathion<br>oxydemeton-methyl* |
| **ROSE CHAFER**<br>**JAPANESE BEETLE**<br>*(Figure 30, page 87)* | Rose chafer is an elongated, fawn-colored beetle (1.5 cm long). The Japanese beetle is metallic green with copper-colored wings and is oval-shaped. They act in a similar manner, emerging from the soil in large numbers from late May to early July; feeding on blooms and leaves of trees and flowers. Often many beetles are found on a single flower, causing serious injury. The beetles eat the tissue between the veins, leaving a lace-like skeleton. **Rose and peony blooms are prime targets, but hollyhock, zinnia, and other flowers are also attacked.** If only a few plants are involved, shake the chafers or beetles from the blooms into a container and destroy them.<br>Spray or dust when beetles are noticed. Carbaryl and diazinon are very poisonous to bees; use in late evening only, when bees are not present, or use methoxychlor. For additional information on larvae and adults, see pages 60 and 70. | carbaryl<br>diazinon<br>methoxychlor |
| **SCALE INSECTS**<br>*(Figure 22, page 85)* | Many different species of these small insects spend most of their lives under protective caps (scales), attached to bark of branches and trunks, and to pine and juniper foliage. The insects suck the sap, weakening the plant. If severely infested, the bark is covered with a crusty layer of scales. The most common are the following:<br>- Golden oak or oakpit scales, small golden discs on or slightly sunken into bark of **oak**, especially **English Oak**;<br>- Oystershell scale, resembling small oystershells, on **ash, dogwood, lilac and willow**, and other smooth-barked plants;<br>- Lecanium scale looks like round, brown knobs on **ash, cedar, crab apple, elm, honeylocust, maple and oak**;<br>- Juniper scale consists of white specks on twigs and foliage of **juniper**;<br>- Pine needle scale appears as white specks on the needles of **pine and spruce**, and occasionally **hemlock, fir, yew**; | |

*(Continued on page 59)*

*Only available in multipurpose mixtures (see pages 5, 80).*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **SCALE INSECTS**<br>(Continued)<br>*(Figure 40, page 88)* | - Cottony maple scale has a cottony, popcorn-like appearance and occurs on **honeylocust and maple**;<br>- Fletcher scale, appears as large, dark brown knobs mainly on **yew**; also on **cedar and juniper**. | |
| | A light infestation may be kept in check by birds and beneficial insects but should be watched for increased numbers. If chemical control is necessary, spray in late April, *before leafbuds break*, when a cold night is not expected. Spray in the morning so the spray dries quickly. This dormant treatment is effective against all species of scales. | dormant oil<br>(not on Japanese and sugar maple or yew)<br>dormant lime sulfur |
| | The newly hatched larvae (crawlers) of the scale insects can be killed during the short time they are exposed before hiding under the scale. Therefore, the correct timing of the spray for each species is essential. | |
| | - for golden oak scale, spray in July at 10 day intervals. | carbaryl<br>chlorpyrifos†<br>malathion |
| | - for oystershell scale, spray about May 25 and repeat 10 days later. | chlorpyrifos†<br>diazinon<br>insecticidal soap<br>malathion |
| | - for lecanium scale, spray in mid-July. Do not use malathion on "Crimson King" Norway maple. | carbaryl<br>chlorpyrifos†<br>diazinon<br>malathion |
| | - for juniper scale, spray in late June. | carbaryl<br>chlorpyrifos†<br>diazinon |
| | - for pine needle scale, spray in late May and again in early June. | chlorpyrifos†<br>malathion |
| | - for cottony maple scale, spray in early July and repeat 10 days later. | carbaryl<br>chlorpyrifos†<br>malathion |
| | - for Fletcher scale, spray in early July or September. | carbaryl<br>chlorpyrifos†<br>diazinon<br>dimethoate |
| **SNAILS, SLUGS** | **Slugs and snails** hide by day in dark, moist places and feed by night. Glistening slime trails are often left as evidence of their presence. The use of mulch aggravates the slug or snail problem. When injury to plants is noticed, apply bait according to label directions. Use bait with care, as it is *attractive and very poisonous to dogs and birds*. Moist bait attracts the slugs; if soil is dry, water lightly. Do not use methiocarb on vegetables. | metaldehyde (bait)<br>methiocarb (bait) |

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**Only available in multipurpose mixtures (see pages 5, 80).*

*†May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF INSECTS ON ORNAMENTAL PLANTS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **SOWBUG OR PILLBUG** | These have flat, oval, gray-brown bodies, about 1 cm long, and have 7 pairs of legs. They are mostly found in damp places under flower pots, boats, etc., or in manure and decaying leaves. They seldom harm plants but are beneficial by breaking down organic matter. They usually should *not* be controlled, but may cause damage to ornamental foliage and flowers. | chlorpyrifos† |
| **SPRUCE BUDWORM** | This insect has been a problem in some years. The 2.5 cm caterpillars eat the needles of **spruce** and **fir** in May or early June. Treat when worms and damage are noticed; examine trees frequently during this period. Malathion discolors blue spruce. | *Bacillus thuringiensis*<br>carbaryl<br>dimethoate<br>malathion<br>permethrin |
| **THRIPS** | Thrips are tiny insects that are seldom seen, as they hide within the plant. They suck plant sap and cause silvery speckled injury on the foliage. Damage is usually most serious on **gladiolus**, but may also occur on **iris, day lily**, and **rose.**<br>On gladiolus, apply a preventive spray or dust when leaves are 30 cm long; treat other plants when damage is noticed. Repeat at 2-week intervals, or as needed. Always dust gladiolus corms before storing for winter, using carbaryl. | carbaryl<br>chlorpyrifos†<br>dimethoate<br>malathion<br>methoxychlor<br>oxydemeton-methyl* |
| **WHITEFLY** | These small insects multiply quickly, and control in the garden is difficult. Swarms of whiteflies are noticeable when plants are disturbed. Young nymphs may be found in large numbers on the underside of leaves. They are sap suckers, causing leaves to wither. They may be tolerated outdoors, but a problem occurs when susceptible potted plants are taken indoors for the winter. At that time, prune severely, removing most of the foliage; then dip plants (except soil and roots) in a solution of soap or household detergent in water. Many plants are attacked by whiteflies, especially **coleus, fuchsia, hibiscus, hollyhock, impatiens, Jerusalem cherry and poinsettia**. For control outdoors, spray or dust at weekly intervals but be sure to apply the insecticide to the underside of foliage as well as the upper surface. Note that whitefly does not overwinter outdoors. | chlorpyrifos†<br>insecticidal soap<br>malathion<br>methoxychlor<br>permethrin |
| **WHITE GRUB**<br>*(Figure 5, page 82)* | These are the larvae of the June or Japanese beetle, European or Rose chafer. They may be a problem when sod is converted to flower beds. The larvae of these species are fat and white with brown heads. They are usually found in a curled "C" position in the soil. Various sizes can be found, depending on age. Young bedding plants and seedlings are most severely damaged by root feeding. Treat soil around plants and thoroughly water. For information on adult damage, see Rose chafer page 58. | chlorpyrifos† |
| **WIREWORM**<br>*(Figure 10, page 83)* | These are larvae of click beetles. They have a hard orange shell, 6 legs and are about 2 cm long. They are found in garden areas previously in sod. Wireworms cause damage to the roots of plants. If many **wireworms** are found, treat the soil *before planting* and work insecticide into the soil to a depth of 10 cm. | |

**Only available in multipurpose mixtures (see pages 5, 80).*

*†May cause injury to some plants. Check product label carefully before use.*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **ASTER YELLOWS**<br>*(Figure 68, page 94)* | This disease is caused by a mycoplasma-like organism. Symptoms are similar to virus diseases. It affects **China aster, calendula, coreopsis, cosmos, delphinium, daisies, marigolds, petunias, phlox, zinnia**, and many other flowers and weeds. **Carrots, celery** and **lettuce** are also attacked. Plants are stunted, top leaves turn yellow, blooms are stunted, distorted, often greenish, may not open, and take on leaf-like form. Carrots get multiple crowns and many lateral roots, tops turn yellow. This disease is spread by the six-spotted leafhopper (not the leafhopper species on potatoes and beans). This leafhopper is extremely difficult to control because of correct timing and lack of an effective insecticide. Only the prompt removal and destroying of affected plants is of some help. | |
| **AUTUMN SHED OF CONIFERS** | All conifers undergo annual needle shed to varying degrees. Beginning in early autumn, foliage of conifers toward the inside of the tree (closest to the trunk) turn yellow or brown and fall. Cedars and many junipers bear scale-like needles covering tiny branchlets. These trees also shed the oldest branchlets in the fall.<br>Trees of low vigor, or under stress from factors such as drought, transplant shock, poor drainage or soil compaction may lose more than one year's quota of foliage. In such cases, identifying the problem and alleviating the stress will minimize autumn shed. | |
| **BACTERIAL SOFT ROT** | Soft rot caused by the bacterium (**Erwinia carotovora**) attacks several ornamentals, particularly **iris, dahlia, chrysanthemum and geranium**. The bacteria enter through wounds causing a rapid, wet rot with an offensive odor.<br>Soft rot of iris usually follows borer infestation. Leaves become withered, with the basal portion wet and shredded. The interior of the rhizome disintegrates into a vile, yellow mass while the epidermis remains intact.<br>No chemical control is available. With iris, divide infected iris, replanting only healthy rhizomes, avoid planting too deeply and control iris borer (page 56). | |
| **BIRCH DIEBACK (Birch Borer)** | European birch trees in particular, are relatively short-lived (15-30 years), shallow-rooted and in home gardens are usually growing under stressful environmental conditions, including poor soil with inadequate moisture. Trees under stress attract bronze birch borers or dieback fungi. The upper and outer branches are girdled first, causing them to die before the main stem is affected. Such a tree gradually dies from the top downwards.<br>Cut and destroy dying branches before May. Improving the vigor of the tree will reduce the risk of infestation, since birch roots do not compete well with lawn grasses. Water the rooting zone deeply several times during the growing season. Apply control for Birch Leafminer (page 51) to reduce stress. | |
| **BLACK SPOT** | A very common disease of **roses** which causes reddish to black spots on the foliage; leaves turn yellow and drop. If the leaves are repeatedly wet by dew, rain or watering the disease soon becomes serious. The loss of leaves reduces the number and the quality of blooms and may so weaken the plants that they do not survive the winter.<br>If no mulch was applied, gather fallen leaves regularly during summer and fall. If mulch is used, apply a fresh layer early in spring after mounded soil for winter protection has been levelled. Avoid watering the foliage; apply water on the soil instead. If this cannot be done, irrigate in the morning, so the leaves will dry quickly. Some nurseries list varieties that are less susceptible to black spot than others. | |

*(Continued on page 62)*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **BLACK SPOT**<br>(Continued) | A dormant spray before leaf buds break helps to control infections on the bark of young twigs. (It also reduces powdery mildew infection and rose scale.) | lime sulfur |
| | Starting when buds burst and until foliage is killed by frost, spray or dust every 7 days in periods of rain or heavy dew or repeated watering, especially when growth is rapid. During dry periods, spray or dust every 14 days. Be sure that the underside of leaves is covered by the spray or dust. | benomyl**<br>captan<br>chlorothalonil<br>copper<br>dichlone*<br>folpet<br>mancozeb*<br>sulfur<br>triforine** |
| **BOTRYTIS BLIGHT (GRAY MOLD)** | A fungus called *Botrytis* attacks a wide variety of ornamental hosts, including **begonia, tulip, peony, petunia, geranium, gladiolus** and **rose**.<br>On **tulip**, the disease begins as small beige to brown spots on leaves and flowers. During wet weather, the disease rapidly kills flowers and leaves, growing down into the stalk and bulbs, often rotting them completely — hence the name "tulip fire".<br>Botrytis typically attacks open or senescing flowers or leaves through wounds, and produces gray fuzzy mold growth on affected plant tissue. Tissue appears rotted and discolored. Hard, black resting structures, called sclerotia, often occur in the diseased tissue, and persist in soil to promote re-infection the next year when another susceptible crop is grown. Remove all fading, senescing, and diseased plant parts promptly. Use fungicides regularly in anticipation of wet weather. | benomyl**<br>captan |
| **CANKER** | Cankers are diseases causing death of the bark in localized areas on the trunks and branches of many species of trees and shrubs. The infection sites usually are different in color from the surrounding bark. The canker area may be depressed, having bark which is cracked, split, or peeling away. Small, dark fruiting bodies may be apparent, especially during moist weather when oozes of white, amber, orange or black spores are produced. These woody plants can defend themselves against infection by various canker-causing fungi if they are growing vigorously and are in good health. However, if these plants are growing poorly due to drought, root damage, pavement around the trunk or other unfavorable conditions, the fungi penetrate the bark and cankers develop. If a canker girdles the trunk, the plant dies. Any wounding of the bark by insects, pruning, or lawnmowers creates an easy opportunity for fungi to penetrate the bark. Cankers can also be caused on the south side of a tree by alternating sunshine during the day and severe freezing at night.<br>**Poplars, especially Lombardy poplars,** are often very severely affected. This disease is so common that Lombardy poplars should not be expected to last more than 15 to 20 years, when some of the trees will have to be replaced. First the foliage on slender branches turns brown, then the tree gradually dies from the top downwards. When partly dead trees are cut near the ground and destroyed, the stump will sprout quickly into a new tree, but it will be reinfected in a few years.<br>The disease **Cytospora Canker of Spruce** is common and damaging to **Colorado blue and Norway spruce,** but will also attack **white spruce, balsam fir, and eastern hemlock**. In spring and early summer the first visible symptom | |

*(Continued on page 63)*

*Only available in multipurpose mixtures (see pages 5, 80).*
**See "Resistance to certain fungicides" on page 50.*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **CANKER**<br>(Continued) | is of needles turning yellow, then brown on one or more lower branches of trees at least 10-15 years of age. Needles fall during the winter leaving unsightly bare branches. This is an indication that cankers have completely girdled the affected branch. Usually clear amber resin exudes copiously from the cankers, dripping onto lower branches and hardening to a white crust. Stresses such as drought and poor soil conditions predispose plants to attack. Remove the infected branches to avoid the spread of the spores by wind and rain, and alleviate potential stresses. The disease badly disfigures trees but seldom kills.<br>On any kind of tree, canker wounds should be cleaned by cutting away diseased parts. Care must be taken to remove all brown or stained inner bark and to ensure that the edges of cuts are smooth and not ragged. An oval-shaped cut with smooth edges helps the tree to close the wound with callous tissue more quickly. While doing this, disinfect the pruning tools after each cut by dipping into 1 part chlorine bleach plus 3 parts water. Treating wounds with tree dressing or pruning paint is not necessary. No chemical control is available. Create the best possible growing conditions by root feeding and watering. Be sure to water especially well during periods of extended drought. | |
| **CEDAR-APPLE, QUINCE RUST**<br>*(Figure 53, page 91)* | Both diseases are caused by fungi with complex life cycles that take 2 years and two hosts for completion. **Cedar-apple rust** infects **red cedar** junipers such as **'Skyrocket'** and also **apple** or **crab apple** as the deciduous alternate hosts. **Quince rust** infects the **red cedar junipers** with **apple, crab apple, quince, hawthorn** or **serviceberry** as alternate deciduous hosts for completion of its life cycle.<br>The fungus overwinters as kidney to irregularly shaped, pitted galls of a few millimetres to several centimetres in diameter, on the twigs or leaves of the juniper. During warm spring rains of mid-May to mid-June, the galls swell producing bright orange jelly-like horns. Spores released from the horns are blown by wind to the deciduous host infecting both leaves and fruit.<br>Early infection on deciduous host appears as small, pale yellow spots. With cedar-apple rust small orange cup-like structures with horn-like protuberances appear by midsummer on the undersurface of the leaves. Quince rust infects only the fruit, causing the calyx end to become puckered and dark green in color. In late summer, spores from these structures are blown back onto the junipers, and cause infection. Remove galls from the junipers. Spray the deciduous hosts from pink flower bud until petal fall using recommended fungicide (Figures C and D, page 40) | ferbam<br>(on fruit trees) |
| **CROWN GALL**<br>*(Figure 69, page 94)* | Crown gall is caused by a soil-borne bacterium that is present in most garden soils. This disease is common on **roses, euonymus, fruit trees, raspberries and many other plants.** Galls or woody swellings develop on the roots or the base of the plant. The bacteria gain entrance through wounds. No chemical control is available. Avoid unnecessary wounds. Do not buy plants with galls on roots. Replace soil where a severely affected plant has grown before replanting. Galls may occur on above ground stems, **eg. forsythia and euonymus.** | |
| **DAMPING-OFF**<br>*(Figure 51 (a), (b) page 90)* | Seedlings, especially those growing in pots or flats indoors or in a cold frame, fall over and die. Stems are brown and thin near soil line. Most seedlings are susceptible to these soil-borne fungi. For treatment, see ''Damping-off'' on page 12. | |

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **DECLINE or DIEBACK of SHADE TREES** | The progressive dying back of branches from the terminal tips is symptomatic of decline. Several major deciduous tree species including **maple, ash, oak** and **beech** are particulary susceptible. Early symptoms include shortened internodes, reduced leaf size and chlorosis of the foliage. Dieback is poorly understood. Root stresses, including soil compaction, poor drainage, site alteration, and high soil temperature, are contributing factors. Decline is often mistaken as verticillium wilt. Some virus and mycoplasma-like organisms have also been shown to cause decline, especially in ash trees. Maintain good tree vigor through proper watering and fertilization practices. | |
| **DIPLODIA TIP BLIGHT** | Mainly **Austrian, Scots,** and **red pine** become infected with this fungus which causes the death of new shoots. Infection occurs in spring when young shoots are elongating. Unfortunately, no fungicides are available for this disease. Pruning off the dead tips and cones, and cleaning off dead needles which hang in the trees and harbor the fungus, can reduce this disease. | |
| **DOG INJURY** | All evergreen foliage, particularly Thuja, is sensitive to urine from male dogs. Injury symptoms include rapid browning of lower foliage which later becomes brown/black in color, with a distinctive greasy appearance. Discolored or burnt foliage will not recover. To avoid future injury protect the lower portion of the shrubs. | |
| **DUTCH ELM DISEASE** | When branches or entire limbs of an **American elm** wither and die, the tree is infected by this disease. Treatment by a qualified arborist (tree service) will prevent disease and cure early infection for 2 years. Treatment is expensive but worthwhile for valuable elms. No chemical treatment is recommended for use by the home gardener. Improve growing conditions by deep watering. Destroy the wood of diseased elms. | |
| **FIRE BLIGHT** | This bacterial disease causes sudden dying of young twigs and sometimes entire branches, leaving a scorched appearance. Susceptible ornamental plants are **cotoneaster, crab apple, hawthorn, mountain ash, firethorn, quince and amelanchier (serviceberry).** This disease also occurs on pear trees and sometimes on apple. Remove and destroy infected twigs and branches 30 cm below scorched part. If pruning shears are used, disinfect blades after each cut in a solution of 1 part chlorine bleach in 4 parts water. Nearby trees may be source of infection. Avoid heavy application of nitrogen fertilizer. | |
| **JUNIPER TIP BLIGHT** | Several fungi cause twigs of junipers, particularly Sabina types, to dieback, becoming brown above a tan-gray canker on a twig. These fungi infect at different times of the year, and thus, are difficult to control without a proper microscopic examination. Prune out diseased tips, through which these fungi re-infect the shrubs. Avoid shearing plants in the fall. Provide good air circulation. Symptoms can be easily confused with winter injury. | copper |
| **ANTHRACNOSE**<br>**LEAF BLOTCH**<br>**LEAF BLIGHT**<br>*(Figure 66, page 94)* | These common and similar diseases affect **maples, London plane tree, sycamore, ash, oak, hawthorn, horse chestnut and catalpa**. Infection starts in early spring, when buds break, from spores released from fallen leaves of previous year. The symptoms appear in late May as small spots developing to obvious large light reddish or dark brown blotches by midsummer. Affected leaves dry out and drop prematurely. These diseases are most severe when May and June are cool, wet and cloudy. | |

*(Continued on page 65)*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **ANTHRACNOSE<br>LEAF BLOTCH<br>LEAF BLIGHT**<br>(Continued) | When a few trees of one kind are fairly isolated it is helpful to gather all fallen leaves, as they carry the infection until the following spring. Dispose of these leaves by burning, composting or in the garbage. This method is not very effective if fallen leaves from similar trees nearby are not destroyed or if the fungus is surviving in cankers on bark and twigs in the tree (i.e. anthracnose of sycamore). Trees which are affected in successive years become weakened and branches gradually die; root-feeding and heavy watering are helpful. | |
| **LEAF SCORCH** | This physiological disorder experienced by **horse chestnut, oak, harlequin maple**, and by **many other kinds of trees**, especially along city streets, appears similar to the fungal-caused leaf blotch. Leaves affected by scorch, however, are brown along the margins and often between the veins. The disorder is caused by hot, dry weather creating stress on the tree and is aggravated by compacted soil and reflected heat. Watering deeply once a week during dry spells may be beneficial. | |
| **LEAF SPOT**<br>of catalpa and hawthorn | Small brown spots occur over the surface of the leaves. The disease is enhanced by wet weather. Rake and destroy all fallen plant debris. Leaf spot is common on **catalpa** and **hawthorn.**<br>If necessary, spray when buds break and repeat twice at 2-week intervals. Spraying in midsummer is useless. | captan<br>copper (spray) |
| **LEAF SPOT**<br>of herbaceous perennials and annuals | Several fungi and bacteria cause leaf spots on many kinds of plants such as: **begonia, coleus, impatiens, marigold, salvia, chrysanthemum, delphinium, zinnia, iris, lily-of-the-valley and phlox**. Leaf spot disease weakens the plant but seldom kills it. If foliage is often wet for many hours, this disease can be severe. Promote quick drying of foliage by adequate spacing, removal of weeds, and avoid watering in the evening. Spray or dust when the first leaf spots show. Bacterial leaf spot diseases are not controlled by fungicides, except copper. | |
| *(Figures 59, 62, pages 92, 93)* | Small dark brown to black spots begin on lower leaves progressing upwards. Spots increase in size, forming large black areas. The dead leaves remain on plants. Remove all infected plant parts that are noticed, especially in the fall, to avoid carry over of the disease into the next growing season. | captan<br>copper<br>folpet<br>mancozeb* |
| **NEEDLE CAST OF SPRUCE** | Rhizophaera needle cast is a foliage disease of **blue and white spruce** causing premature death and shedding of needles. The fungus attacks one-year-old needles on the lower tree branches first, usually in May and June. In late summer and early fall, the infected one-year-old needles begin to show a yellow mottling, later turning brown or purplish-brown. The rows of tiny black dots on the needles is a very distinctive feature. The disease overwinters in infected needles on the tree, or in fallen needles, being spread the following spring by wind and splashing water. If trees are diagnosed as being infected, commerical tree maintenance personnel can apply a chemical control treatment. | |
| **OEDEMA** | This physiological disorder is associated with excess soil moisture and reduced transpiration. Water-soaked spots which develop into corky ridges of tissue form mainly on lower leaf surfaces. Leaves may turn yellow. This problem is common with **ivy geranium and other waxy-leaved annuals**. Avoid excessive soil moisture conditions during high humidity, low temperature conditions. | |

**Only available in multipurpose mixtures (see pages 5, 80).*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **POWDERY MILDEW**<br>*(Figure 63, page 93)* | The first symptom of this disease is white powdery spots on the stems and leaves. If widespread, the entire leaf may become infected. On some plants, such as roses, the young shoots are infected first. On other plants, such as phlox, the disease starts on lower leaves. Powdery mildew can be expected after midsummer, when humidity is high and nights are cool. This disease is unsightly, but generally does not not do serious harm to most plants. It commonly occurs on **begonia, chrysanthemum, crab apple, delphinium, lilac, phlox, privet, rose, snapdragon,** and **zinnia**. Tuberous begonia and zinnia may be seriously damaged. Plant sensitive plants in sunny locations with good air circulation. Avoid overhead watering late in the day. | |
| | Spray or dust when mildew is first noticed and repeat at 5- to 10-day intervals until disease is under control. To avoid injury to plants, do not apply sulfur when the temperature is above 27°C. Do not use the same chemical for season-long control and year after year for mildew control. Alternate with another from this list, especially if benomyl is used. | benomyl**<br>copper<br>cycloheximide<br>dinocap*<br>folpet<br>sulfur<br>triforine** (on rose, phlox and zinnia only) |
| **ROOT ROT** | Many fungi such as *Pythium, Phytophthora, Rhizoctonia,* and *Fusarium* cause root and lower stem rots of woody and herbaceous ornamentals. These soil-dwelling fungi usually are a problem when unsterile soil is used when growing transplants, or when soil is wet for extended periods of time outdoors. | |
| | *Armillaria* root rot mainly attacks woody plants weakened by drought and other stress factors. The roots and lower trunk or stems have white fans of fungus growth underneath the bark, and the innner wood is discolored brown. Black shoestring-like strands called rhizomorphs are found on the root surfaces, and spread the fungus from plant to plant as they grow through soil. In some years during fall, clusters of honey-colored mushrooms may appear at the base of infected plants. No chemical control is effective against *Armillaria.* | |
| | Remove and destroy roots and surrounding infested soil near all infected plants. Use sterile soil in growing transplants. Do not plant transplants or woody plants too deeply. Supply adequate but not too much water, provide good soil drainage, and avoid overcrowding plants in the garden. | |
| | With bulbs, do not plant those which have sunken or discolored spots. All others should be dusted or treated with a slurry or fungicide, and then allowed to dry before storage or planting. | captan<br>benomyl** |
| | Soil can also be treated with captan as a preventative measure, mixing in the fungicide uniformly before planting either outdoors or for growing transplants indoors. This is not usually very effective outdoors, because transplants may already be diseased, and cannot be "cured" completely. | captan |
| **RUSTS**<br>*(Figure 65, page 94)* | The rust fungi are host specific with **hollyhock, alpine currant, geranium** and **snapdragon** being commonly attacked. Orange to reddish-brown spots or lesions bearing powdery masses of spores appear by midsummer on the undersurface of leaves and on stems. Rusts are cool weather diseases which require free water for germination and infection of leaf tissue. Control is difficult. Avoid overhead watering late in the day. Destroy all infected leaves or plant debris.<br>For cedar-apple and quince rust, see page 63. | |

*(Continued on page 67)*

**Only available in multipurpose mixtures (see pages 5, 80).*

***See "Resistance to certain fungicides" on page 50.*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **RUSTS**<br>(Continued) | With **hollyhock rust**, control can only be achieved if all common mallow and round leaf mallow weeds are removed from the area because of their susceptibility to the same rust.<br>**White Pine Blister Rust** of white pine requires one of the alternate hosts, red or black currant, to complete its complex life cycle. The rust fungus initially invades branches and slowly spreads into the trunk, eventually killing the tree. The rust infects the living bark, causing it to become orange as the stem swells and blisters. The blisters on the pine release spores which blow to currant leaves on which the red rust-stage develops. In late summer, spores are released from the infected currant leaves and infect healthy pines. There is no chemical control for rust on pine. Prune off infected branches. For control of rust on currant, see rust of currant page 34. Do not plant white pine and currants in close proximity. | |
| **SCAB**<br>*(Figures 46, and 50, pages 89 and 90)* | This disease affects **crab apple** and **firethorn**. See description on page 30. As the quality of the fruit of flowering crab apples is not important, control need not be as effective as for the fruiting apple tree. However, serious damage to foliage should be prevented. Proper pruning to improve air movement is beneficial. Resistant varieties of firethorn and crab apple are available. Spray when first leaf buds break and repeat at 7- to 10-day intervals during May and June, particularly during rainy periods. Do not apply mixtures containing an insecticide during bloom. Dusting is not very effective. | benomyl**<br>captan<br>lime sulfur (on crab apple only) |
| **SOOTY MOLD**<br>on leaves | A black sooty growth that may partially or completely cover needles or leaves of trees and shrubs caused by various fungi growing on the honeydew secretion of sucking insects such as aphids, mealybugs and scales.<br>Control the insect problem with appropriate insecticide. Sooty mold will disappear as the food supply becomes depleted. | |
| **TAR SPOT OF MAPLE** | The characteristic symptoms of this disease are irregular, black tar-like spots (0.5 - 2.0 cm in diameter) that become evident midsummer on the upper surface of infected leaves. The lower leaf surface beneath the tar spot turns brown. Leaves with multiple infections will drop prematurely. The fungus survives over winter on the fallen diseased leaves, infecting new leaves the following spring. Silver, red and Norway maple are most susceptible, but sugar and sycamore maple can be attacked. Young trees having less total leaf area, rather than mature established trees, are more likely to be weakened by leaf drop.<br>Although the spots detract from the appearance of the leaves, the disease is seldom so injurious to justify spraying with a fungicide. Raking up and destroying infected leaves in the fall will reduce overwintering inoculum. | |
| **WALNUT INJURY**<br>(not a true disease) | The roots of the **black walnut** and **butternut** will have a harmful effect on many species of plants growing within the root zone of these trees. (English walnut does not have this effect.) If poor growth of certain plant species is noticed, avoid planting them in the future. The best remedy is to remove the tree, but the harmful effects last for at least one year. See also walnut injury, page 13. | |
| **WHITE MOLD**<br>*(Figure 64, page 94)* | This disease caused by *Sclerotinia* can affect most densely growing annual plants, such as marigolds, during periods of wet weather or frequent watering. The symptoms are rapid browning and rotting of stems and foliage with white cotton-like tufts and round, black fungal bodies. Remove diseased plants and fallen leaves as soon as noticed and throw them in the garbage. Do not work them into the soil or compost. Avoid watering on foliage. When planting, allow adequate spacing for good air circulation. No chemical control is available. | |

***See "Resistance to certain fungicides" on page 50.*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides If Necessary |
|---|---|---|
| **BACTERIAL WILTS AND BLIGHTS** | Bacterial diseases are often classified as wilts (as in geranium wilt) or blights (as in lilac blight).<br>Wilt-causing bacteria tend to clog up the vascular tissue, inhibiting the flow of products in the xylem and phloem, while blights attack the outer layers of tissue and the shoots first.<br>Bacteria enter plants through wounds, pruning cuts, and stomates of the leaves. Bacteria can be spread mechanically, but more commonly this is done by splashing water and rain.<br>Wilt diseases like **bacteria wilt of geranium** are distinguished by large "V" shaped necrotic areas in leaves, leaf yellowing and wilting, or a flaccid appearance to all leaves on a branch. Gray or black streaking may be apparent on leaf petioles and stems. Under warm, humid conditions plants collapse very quickly. Removal and destruction of all infected plant material is required. Avoid planting geraniums in the same areas for at least one year.<br>**Lilac blight** may first appear as a black spotting on leaves and stems. Flower buds, young leaves, and shoots may become completely blackened and killed. Infection occurs in early spring during extended periods of wet weather. Remove all infected tissue and destroy. No chemical controls are available for bacterial diseases. | |
| **FUSARIUM WILT** | This soil-borne fungus is the cause of many rots and wilts of herbaceous ornamentals. **Lily, tulip, narcissus, crocus** can be attacked by one type of *Fusarium* that causes a rot at the basal plate of the bulb. The rotted tissue is usually purplish-brown with pink threads of mycelium.<br>Another type of *Fusarium* attacks **Dianthus**, while yet another affects **garden chrysanthemum**. These both show symptoms of chlorosis of leaves on one side of the stem or a complete wilting of a branch or shoot. Stunting may occur. Stem tissue at soil line exhibits a reddish-brown discoloration.<br>Dig out and remove all infected plant parts including bulbs and roots. Replace with plants which are not susceptible to the same type of *Fusarium*. | benomyl** |
| **VERTICILLIUM WILT** | This soil-borne fungus attacks many ornamental trees, shrubs and flowers. The fungus enters through the roots and gradually plugs the water conducting tissue. Susceptible plants include **maple, linden, catalpa, dahlia, aster, chrysanthemum, impatiens, phlox** and **snapdragon**. Once the soil is infested, it will remain so indefinitely. Sudden wilting and yellowing of foliage followed by premature defoliation are the first symptoms. Trees may show wilting after many years of growth. Only one limb may die while others remain healthy for a time. Black, dark brown to olive green streaks may be found in the outer rings of the wood. With maple, improved vigor of partially infected trees through fertilization and watering will help.<br>If wilt kills a tree, replant with a non-susceptible tree or shrub such as walnut, oak, European mountain ash, sycamore, all conifers (spruce, fir, pine, etc.), boxwood, pear and mulberry. | |

***See "Resistance to certain fungicides" on page 50.*

# CONTROL OF DISEASES ON ORNAMENTAL PLANTS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| WOOD DECAY | Many different **wood decay fungi** attack woody ornamentals, usually entering through wounds caused by pruning, insects, storm damage, winter injury, mechanical damage, etc. Healthy woody plants normally close wounds with callous tissue (like scar tissue), and prevent wood decay fungi from penetrating into inner wood by producing chemical barriers—a process called compartmentalization. However, when stress factors such as drought, defoliation, soil disturbances, etc., reduce the vigor of woody plants, these normal defence mechanisms cannot prevent infection and establishment of wood decay pathogens. These fungi grow upwards and downwards in the column of wood associated with the wound, causing discoloration, rotting, and sometimes complete disintegration of the wood. Structurally weak or hollow trees can result, presenting a hazard to nearby activities, buildings or property. After growing extensively inside the plant, these fungi produce reproductive structures on the bark or lower trunk and roots: either mushrooms, shelf-like bracket fungi, corks, or flattened pore-filled growths.<br>Affected trees should be examined by a competent arborist for structural soundness, and dead wood pruned out properly. No chemicals are effective against these fungi.<br>Avoid wounding trees as much as possible, and surgically remove loose bark and jagged edges from wounds. Practice proper pruning methods as described in OMAF Publication 483, *Pruning Ornamentals.*<br>Research has shown that tree wound dressing or pruning paint are of no value in promoting wound closure and in preventing tree decay. Identify and correct stress factors, provide adequate water, and occasional fertilization (see OMAF Factsheet, *Fertilizing Trees and Shrubs in the Landscape,* Order No. 83-040) will reduce wood decay problems. | |

# INSECT AND DISEASE CONTROL ON LAWNS

**If lawns turn brown in the summer, in spite of watering or rainfall, *insects* are usually the cause, as they continually trim the roots. Healthy grass has deep roots and can withstand considerable drought before turning brown.**

**The rate of application for lawn insecticides can be found on the product label. It is important that the proper amount of the chemical be applied on the specified surface area. The rate is expressed on this basis. If the recommended insecticides are applied at the *correct* rate and in the recommended manner, the treatment is not harmful to pets, birds or earthworms.**

**For a more detailed description of these insect and disease problems and others not described here, the serious lawn enthusiast is recommended to purchase OMAF Publication 162, *Turfgrass Diseases and Insect Pests.***

# INSECT CONTROL ON LAWNS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **ANT** | Anthills make the lawn surface uneven and may be objectionable; however, ants do not injure lawn grasses. Separate treatment against ants is usually not necessary, as treatment against other insects will control them. | carbaryl<br>chlorpyrifos<br>diazinon |
| **CHINCH BUG** | Chinch bugs have piercing mouthparts which enable them to suck the sap from the stems of grass plants, often causing them to wither and die. The small nymphs begin feeding in early May but damage does not become apparent until July when warm temperatures and drought conditions often prevail. The tiny nymphs are bright red when they first hatch, then turn gray as they become larger. Chinch bugs are difficult to detect in the lawn early in the year because they move down into the thatch when disturbed. In July, if there are dead sunken patches in your lawn that seem to be spreading from hedgerows, trees or flower beds, flood this area with water and place a white cloth over it. The chinch bugs will crawl onto the cloth where they can be more easily seen. Another method for detecting chinch bugs is to force a large can, from which the bottom has been removed, into the sod and fill it with water. The chinch bugs will float to the surface after a few minutes. Serious damage to lawns occurs in August, so if an insecticide treatment is applied in July renovation of damaged areas can be avoided. *Water the lawn thoroughly before the insecticide is applied. Do not water the lawn for 2 days after application.* | carbaryl<br>chlorpyrifos<br>diazinon |
|  | The greatest injury from chinch bug will often occur more quickly on heavily fertilized lawns with lush growth. The greater the thickness of the thatch layer, the greater the chinch bug development. Adequate soil moisture will suppress chinch bug populations. |  |
| **GRUBS**<br>*(Figure 5, page 82)* | The **June beetle** larva, or white grub, is a C-shaped grub with a brown head and three pairs of long legs. It requires 3 years to develop into an adult while feeding under sod. The adult beetle is dark brown, about 3 cm long, and is often seen at night near lights. It feeds on foliage of trees and shrubs. | chlorpyrifos |
|  | The **Japanese beetle** larva is similar to that of the June Beetle but only about half as big when mature. It requires only a single year to complete its life cycle. The adult beetle, which is metallic green and bronze in colour, emerges in early July. It feeds on a variety of fruits and shrubs before the female deposits eggs in the sod. Only a few small areas of the province have had infestations. | chlorpyrifos |
|  | The **European chafer** larva also resembles the white grub of the June beetle but is somewhat smaller. It completes its life cycle in one year. The adult resembles the June beetle but does not feed on trees and flowers to any extent. The adult chafer can be observed swarming in trees on warm evenings in late June and early July. The females drop out of trees and lay their eggs in the surrounding sod. | chlorpyrifos |
|  | Infestations of chafers have been reported from the Niagara Peninsula and inland along the north shores of Lakes Erie and Ontario. |  |
|  | The presence of grubs may be suspected if irregular patches of lawns gradually turn brown in summer. If shallow digging reveals many grubs or if skunks or other small mammals are digging in the lawn, it is necessary to apply an insecticide. The best time for treatment is just after eggs have been laid in early to mid-July, or in mid-September when the turf is moist. |  |

*(Continued on page 71)*

# INSECT CONTROL ON LAWNS

| Insect | Descriptions and Treatments | Use One of these Insecticides if Necessary |
|---|---|---|
| **GRUBS** (continued) | *Immediately after application, thoroughly water the sod.*<br>The extent of damage by grubs will depend on the vigor of the turf and soil moisture. Grubs feeding in spring and fall do not cause visible damage, as the temperatures are cooler and root growth by the turf grasses is active. If grubs are detected during warm, dry periods of the growing season, irrigate and fertilize in an attempt to maintain turf vigor and compensate for the root feeding damage caused by the grubs.<br>Avoid excess thatch as this decreases stress tolerance of the lawn and makes it more difficult for chemical control products to penetrate and reach the target area beneath the thatch layer. Maintain the height of the grass higher to encourage greater root growth. | |
| **SOD WEBWORM** (also called lawn moth) | Young worms skeletonize grass blades; older worms cut them off completely. A symptom of sod webworm infestation is irregular brown patches of turf. As damage increases, large areas may be affected. The presence of small buff-colored moths darting out of the grass indicates an infestation; damage may begin to occur within 2 weeks of a flight period.<br>Spray when damage is first noticed. Do not water or mow the lawn for several days following a spray for sod webworm. | carbaryl<br>chlorpyrifos<br>diazinon |
| **TURFGRASS SCALE** | The **turfgrass scale** is a small, oval, 3-4 mm long, yellow-brown insect which has been found primarily in sodded lawns. Feeding at the base of grass plants by sucking plant sap, these scale insects have not yet been found to cause serious damage to lawns. Female scales lay eggs in cottony masses near the soil line, which hatch in late June and early July. These young, called crawlers, are very tiny, red, and disperse everywhere, leaving red stains when crushed, causing a general nuisance. Although infested grass may green-up more slowly in spring, no control is necessary, and normal spraying for chinch bugs will also control the crawlers. | |

# DISEASE CONTROL ON LAWNS

Diseases are seldom a problem in the average home lawn but can be important in lawns which contain a large proportion of fine turfgrass, such as bentgrass, or those which are maintained for top quality appearance. It is important to distinguish between disease and insect damage because while symptoms are sometimes similar, measures for control are quite different. Where the use of fungicide is recommended, make certain that it is used according to directions on the product label.

The following program will minimize turf disease and insect problems.

1. Provide adequate, but not excessive fertility. Excessive nitrogen application, particularly in spring, results in lush, succulent growth which is more susceptible to diseases. Fertilizer application in hot weather may also burn the grass, or provide conditions which favor brown patch or other summer diseases.
2. Water the lawn thoroughly (only as necessary) in the morning hours. Excessive moisture, particularly in the evening, favors disease.
3. Mow turf early in the day, as often as necessary, with a sharp mower. Dull mowers and evening mowing leave open wounds which are readily infected by disease-causing fungi. Do not remove more than 1/4-1/3 of the leaf surface in any one mowing. Excessive removal reduces the ability of the turf to regrow after mowing, and makes grass more vulnerable to injury from disease or pests.

*(Continued on page 72)*

4. Remove excess thatch — the brown accumulated layer of organic material between the leaves and soil. If thatch is greater than 1 cm deep, de-thatching is recommended.

5. Turf-type perennial rye grass varieties (Barry, Blazer, Fiesta, Fiesta II, Manhattan II, Omega II, Palmer, Pennant, and Yorktown) are recommended for overseeding problem areas, as turf-type perennial rye grass has rapid germination and establishment rate.

# DISEASE CONTROL ON LAWNS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **SNOW MOLD** | Roughly circular to irregular spots or patches of dead grass appear as the snow melts. Patches may be covered with a grayish-white mold or may be bleached brownish in color. Apply a fungicide to the dormant grass in late fall before snow cover (late October-November). Disperse snow banks to facilitate rapid melting and drying in early spring.<br>Avoid succulent turf in late fall. Keep turf mowed until leaf growth ceases. Minimize thatch, as this is a perfect environment for dormant sclerotia of the pathogen.<br>Usually chemical control of snow mold is not required in areas where snow cover is less than 90 days. If snow mold damage is present after snow melt, vigorously rake matted areas and lightly fertilize to promote new growth.<br>Fusarium patch is caused by the same pathogen as pink snow mold but develops without snow cover. Fusarium patch occurs during the cool wet weather of spring and fall. Avoid succulent turf growth and if necessary use 1/2-2/3 rate at first sign of disease. | chlorothalonil |
| **LEAF SPOT** (also called melting-out) (Helminthosporium) | Small, oval, brown to purplish-brown spots appearing on leaves between April and June. In prolonged dull weather the spots spread to the stems and crowns and cause thinning or dead patches in early summer. Use a resistant variety of grass such as Baron, Sydsport, or Touchdown Kentucky bluegrass. Apply a fungicide in early spring when first spots appear, then repeat the treatment 10 to 14 days later. Do not mow or water grass after treatment with *chlorothalonil* until grass is thoroughly dry (preferably 24 hours). | chlorothalonil<br>maneb |
| **DOLLAR SPOT** (Sclerotinia) | Small, circular, bleached dead spots occur from June to October, enlarge to 10-15 cm in diameter in lawn grass, or overlap when severe to cause large dead areas. Edges of bleached parts of the grass blades are reddish-brown.<br>Cobweb-like fungus growth is present on spots in early morning before the dew dries off. Maintain adequate fertility. Dollar spot is favored by low nitrogen levels, and can often be corrected by applying nitrogen fertilizer. Lawns with a history of dollar spot may also require fungicides, beginning when the disease appears in June or August-September. Do not mow or water grass after treatment with *chlorothalonil* until grass is thoroughly dry. | benomyl**<br>chlorothalonil |

***See "Resistance to certain fungicides" on page 50.*

# DISEASE CONTROL ON LAWNS

| Disease | Descriptions and Treatments | Use One of these Fungicides if Necessary |
|---|---|---|
| **BROWN PATCH**<br>(Rhizoctonia) | Roughly circular or crescent shaped brown patches develop, often with a central green tuft of grass, during the hot, humid weather of June to September. Highly maintained lawns are more prone to this disease. The fungus attacks lawns more readily at temperatures between 25-30°C when the night temperature is higher than 20°C. The disease is often more severe in areas which are shaded or have poor air circulation. Pruning of trees and shrubs and improving air movement in affected areas will reduce the effects of this disease. Avoid applying fertilizers which are high in nitrogen during hot weather. Control thatch. If the lawn has a history of this disease, apply the fungicide in anticipation of the above weather conditions, and repeat at 10-14 day intervals during these conditions. Do not mow or water grass after treatment with *chlorothalonil* until grass is thoroughly dry. | benomyl**<br>chlorothalonil |
| **OTHER PATCH DISEASES** | Frequently in high maintenance lawns, irregularly shaped areas and patches, some with tufts of green grass in the middle (a symptom called frog-eye), develop after periods of hot, humid weather. Several disease-causing fungi which rot the roots and crowns of grass plants are responsible. When periods of stress occur, such as drought or humid weather with night and day temperatures of over 20°C and 28°C, the infected plants die.<br>**Necrotic ring spot** commonly occurs on lawns 3-4 years after establishment from sod. Symptoms occur from September to October.<br>**Summer patch** symptoms usually occur from July to August. No chemical controls are available. Maintain balanced fertility, avoid drought stress and excess thatch. Overseed affected areas with turf-type perennial rye grass cultivars, as these are not seriously affected by Necrotic Ring Spot or Summer Patch. | |
| **POWDERY MILDEW** | Grayish-white, powdery masses on leaves and stems occur in shaded areas in cooler weather, especially in fall. If severe, leaves may turn yellow and die. Use resistant grass varieties.<br>Encourage air circulation by removing shelter where feasible. | |
| **MUSHROOMS<br>TOADSTOOLS<br>FAIRY RINGS** | **Mushrooms and toadstools** are sometimes a nuisance but do not cause any damage to the grass. They grow on organic matter in the ground, usually decaying roots or scrap lumber. Removal of such organic matter will help reduce growth of these fungi.<br>**Fairy ring**, which is also caused by a fungus in the soil, may cause considerable damage by weakening and sometimes killing the grass in circular patterns. There is no satisfactory control for this problem. Heavy raking or aerifying, fertilizing and frequent heavy watering helps to stimulate regrowth of grass to mask the effect of damage. | |
| **SLIME MOLDS** | Slime molds are fungi which produce masses of yellowish, bluish-gray or blackish slimy growths on the leaves of grass. The slimy growth changes to dry crust-like globules which are spore-producing structures of the fungus. With dry weather, sunshine, or a vigorous raking, the mold disappears. Although unsightly, slime molds are not harmful and do not require a chemical control. | |

***See "Resistance to certain fungicides" on page 50.*

# DISEASE CONTROL ON LAWNS

| Disease | Descriptions and Treatments | Use One of these Fungicides If Necessary |
|---|---|---|
| **DOG INJURY** | Symptoms usually include circular or oblong patches of dead turf surrounded by a dark green more rapidly growing ring of turf. Injury results from dogs urinating on the lawn, killing the above ground portions of the turf. Recovery usually occurs within 2 or 3 weeks under favorable moisture conditions. However, severely damaged lawns may have to be renovated. Avoid the problem by keeping the dog off of the lawn. Thoroughly watering the damaged spots will help leach salts from the urine. | |
| **MOSS** | Heavy shade, low fertility, or damp, poorly drained soils will encourage the growth of moss. Improving the drainage or the fertilizer program for the lawn may help to eliminate the problem. Soil analyses for nutrient and pH status is recommended before changing the fertilizer program. See page 76 for soil testing laboratories. In heavy shade, consideration should be given to the use of ground covers such as Vinca, Pachysandra or English ivy. | |

Additional information can be found in the Ontario Ministry of Agriculture and Food Publication 162, *Turfgrass Disease and Insect Pests* (see page 75).

# REDUCING OR PREVENTING DAMAGE BY RABBITS, MICE, MOLES AND SKUNKS

## Rabbits

During the winter, when feed is scarce, rabbits eat bark, twigs and buds of fruit trees and many ornamental trees and shrubs. When the surface of the snow is frozen hard, they can reach a considerable height. If completely girdled, trees, shrubs or single branches die. As protection against rabbits, a coil or cylinder of chicken netting can be placed around individual trees or shrubs. Plastic tree guards are available from garden supply stores. They must be tall enough to give protection under the highest possible snow conditions.

There are repellants on the market such as Rabbit Repell and Skoot which can be brushed or sprayed on the bark. This should be done in late fall before a major snowfall. At the time of application the bark must be dry and rain should not be expected until the repellant has dried. One treatment properly applied gives protection until spring. Rabbits (and also deer) are repelled by the bitter taste but they are not harmed in any way.

## Mice and Rats

In winter, mice live and travel in and on the soil, but always under the snow. Hence, the damage they cause to the bark and roots, as well as turfgrass, is not noticed until spring. Trees can be protected by placing a guard around them made of woven wire (screen) with a mesh size of about 1 cm. This guard should be dug into the soil to a depth of about 5 cm and should be surrounded by stones to prevent digging. Maintain a grass free areas around young trees and shrubs. For further information, see OMAF Factsheet, *Rodent and Deer Control in Orchards*, Order No. 89-122.

The use of repellants on trees and shrubs, as discussed for rabbits, is also effective for mice but plenty of crushed stone is needed to prevent mice from feeding below the treated bark or on the roots.

Poisonous baits can be used to reduce the mouse population. Most baits are anticoagulants which means that they reduce the clotting of the blood and cause external or internal bleeding. Mice die painlessly after eating the bait over a period of 3 to 10 days. Therefore, a continuous supply of bait must be available to the mice. In order to keep bait out of reach of children, pets and birds, it must be placed in bait stations made of empty cans with a hole small enough so that only mice can enter. These bait stations also serve to keep the bait dry. Anticoagulant rodenticides contain either warfarin, chlorophacinone, brodifacoum, sulfaquinoxaline, calciferol or bromadiolone (not an anticoagulant). These baits are sold under various brand names. See list on page 81.

## Moles

Moles can do serious damage to lawns. They feed on earthworms, grubs and other soil insects. Except for setting traps, the only method to reduce the mole population is to treat the lawn with an insecticide to control grubs (see page 70). This induces moles to go elsewhere in search of food. As this treatment does not kill earthworms, it will not be effective against moles where earthworms are a substantial part of their food supply. It should be kept in mind that moles are beneficial animals.

## Skunks

When these mammals are searching for grubs, they make many small holes in lawns. By treating the lawn with an insecticide their food supply is eliminated (see page 70).

## Squirrels

Squirrels may strip bark from maples, eat buds of trees, nibble on cherry, peach, pear and apple fruits and dig up bulbs planted in the garden as well as planting acorns and black walnuts in flower beds where they are not wanted.

Pieces of galvanized wire netting secured with rocks or pegged over newly planted bulbs are usually very effective. Trapping squirrels in the garden using peanut butter as bait in a live trap and releasing the animals far from home will reduce the squirrel population. They must be released at least 20 km from the point of capture, since squirrels have otherwise been known to return to the same location. However, because other squirrels soon move in, the trapping must be an ongoing program. Larger traps may be helpful in control of rabbits and groundhogs. A 45-50 cm sleeve of aluminum, such as that used on roofs, nailed to the trunk will prevent squirrel damage if there are no other trees from which the squirrels can jump. These strips should be at least 2 m in height and all branches hanging lower than 2 m should be pruned off. The same method can be used to prevent porcupines from climbing a tree to feed on bark in the top. One end of the strip is nailed down at the corners and the other end is tucked under to hold it in place. Allow enough length for expansion of the trunk as the tree grows and loosen the nails periodically so the corners do not become embedded in the bark.

## Woodchucks or Groundhogs

These occasionally invade gardens to feed on garden produce and ruin more plants in digging burrows. Cartridges such as the Giant Destroyer lit and placed in the burrows will eliminate the animals. It will be necessary to obtain the help of neighbors to control groundhogs coming from adjacent property. Fencing is an alternative. The base must be buried and turned outward in trench to keep the animals from tunnelling under the fence.

# LIST OF AVAILABLE PUBLICATIONS AND FACTSHEETS

Publications and Factsheets are available free of charge (unless otherwise stated) from the Ontario Ministry of Agriculture and Food, Consumer Information Centre, 801 Bay St. Toronto, Ontario M7A 2B2, or from your local County Agricultural Office.

| No. | Publication |
|---|---|
| 162 | *Turfgrass Diseases and Insect Pests — for sale only — $3.00 per copy* |
| 264 | *Flowering Bulbs for Canadian Gardens* |
| 358 | *Herbaceous Perennials* |
| 392 | *Pruning and Training Fruit Trees* |
| 483 | *Pruning Ornamentals* |
| 494 | *Nut Culture in Ontario* |
| 505 | *Ontario Weeds — for sale only — $5.00 per copy* |
| 536 | *Vegetable Garden Requirements* |

| Agdex No.* | Factsheet | Order Number |
|---|---|---|
| 210/07 | *Critical Temperature for Fruit Tree Blossoms* | 72-101 |
| 210/14 | *Apple and Pear Varieties for the Home Garden* | 81-006 |
| 210/14 | *Fruit Trees in the Home Garden* | 81-046 |
| 210/32 | *Stone Fruit Varieties for the Home Garden* | 85-120 |
| 211/634 | *Apple Maggot* | 88-093 |
| 211/634 | *Apple Scab* | 86-028 |
| 211/634 | *Cedar-Apple Rust and Quince Rust* | 83-020 |
| 212/624 | *Scale Insects on Peach* | 83-075 |
| 212/624 | *Tarnished Plant Bug* | 83-027 |
| 212/632 | *Diseases of Grape in Ontario* | 87-014 |
| 212/632 | *Insect Pests of Grape in Ontario* | 87-013 |
| 212/634 | *Black Knot of Plums and Cherries* | 83-026 |
| 212/634 | *Brown Rot* | 85-038 |
| 212/634 | *Peach Leaf Curl* | 83-071 |
| 214/11 | *Growing Apricots* | 86-013 |
| 231/12 | *Grapes in the Home Garden* | 85-121 |
| 234/20 | *Growing Blackberries, Purple and Black Raspberries* | 88-056 |
| 235/12 | *Blueberries for Home Gardens* | 78-030 |
| 236/12 | *Currants and Gooseberries* | 88-012 |
| 237/12 | *Raspberries and Blackberries for Home Gardens* | 88-063 |
| 246/80 | *Black Walnut Toxicity* | 84-050 |
| 252/635 | *Bacterial Diseases of Cruciferous Crops* | 86-046 |
| 252/635 | *Fungal Diseases of Cruciferous Crops* | 85-043 |
| 254/13 | *Growing Rhubarb* | 79-019 |
| 254/14 | *Growing Asparagus in the Home Garden* | 87-001 |
| 254/625 | *Insect Pests of Asparagus* | 82-061 |
| 254/635 | *Diseases of Asparagus* | 82-045 |
| 256/20 | *Growing Pickling Cucumbers* | 89-105 |
| 257/635 | *Backleg of Potatoes* | 79-038 |
| 257/635 | *Late Blight of Potatoes* | 79-043 |
| 257/635 | *Virus Diseases of Tomato and Pepper* | 73-068 |

*(Continued on page 76)*

| Agdex No.* | Factsheet | Order Number |
|---|---|---|
| 258/13 | *Garlic Production* | 89-096 |
| 258/605 | *Carrot Insects* | 81-007 |
| 258/635 | *Field Diseases of Onions* | 81-003 |
| 263/14 | *Herb Gardening* | 76-016 |
| 270/542 | *Fertilizing Trees and Shrubs in the Landscape* | 83-040 |
| 270/716 | *Security Lighting Effects on Landscape Plants* | 76-025 |
| 273 | *Lawn Maintenance* | 87-077 |
| 273 | *Lawn Renovation* | |
| 273/626 | *Grubs in Lawns* | 84-049 |
| 275 | *Planting Trees in the Landscape* | 89-115 |
| 275/636 | *Common Disorders of Broad-Leaved Trees* | 77-031 |
| 276/636 | *Juniper Dieback* | 83-085 |
| 281 | *Flowering Annuals for the Home Garden* | |
| 282/14 | *Garden Irises* | 85-040 |
| 500 | *Soil and Fertilizer Information for Home Lawns and Gardens* | 89-124 |
| 537 | *Composting in the Home Garden* | 79-016 |
| 610 | *Slugs* | 83-051 |
| 626 | *Hairy Chinch Bugs in Lawns* | 82-024 |
| 647 | *Poison Ivy* | 88-104 |
| 675 | *Sap Beetles* | 89-106 |

**When ordering publications, please refer to Agdex number and title.*

## PEST DIAGNOSTIC AND ADVISORY SERVICES FOR HOME GARDENS

If a problem is not covered in this publication or if you want confirmation of the cause of a suspected problem, the Pest Diagnostic and Advisory Clinic, University of Guelph, is available to the public for inquiries on a broad range of pest problems. For a nominal fee, samples of insects, mites, rodents and other pests, plant diseases, weeds, mushrooms and poisonous or wild plants will be examined and identified. The Clinic is a cooperative service of the Ontario Ministry of Agriculture and Food and the Ontario Agriculture College, University of Guelph.

In order to be of maximum value, specimens should be as fresh and as typical of the problem as possible. Complete background information about the problem is also required. Instructions on how to send your specimens, and questions to guide you in providing complete background information, and fee schedules are available from:

Pest Diagnostic and Advisory Clinic
Rm B14 Graham Hall
University of Guelph
Guelph, Ontario N1G 2W1

(519) 824-4120, ext. 2700, 2701

Business hours: 8:30 a.m. - 12 noon, 1:30 - 4:30 p.m. Monday through Friday. Telephone consultation during May 1 - October 1 is available only in the afternoon.

### Soil Testing for pH and Nutrient Requirements

Laboratories, accredited by the Ontario Ministry of Agriculture and Food, provide a soil testing service specifically designed for the homeowner. Fertilizer recommendations based on soil test results are provided for home lawns, vegetable and flower gardens, trees and shrubs, blueberries, rhododendroms and azaleas.

Soil Sample Kits, including directions for taking soil samples and fee schedules, are available from the Ontario Ministry of Agriculture and Food, Consumer Information Centre, 801 Bay Street, Toronto, Ontario, M7A 2B2, and from local offices of the Ontario Ministry of Agriculture and Food.

## AVAILABLE INSECTICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

| COMMON CHEMICAL NAME AND CONCENTRATION OF ACTIVE INGREDIENT (TRADE NAMES IN BRACKETS) SPRAY, DUST GRANULAR ETC. | PERMITTED USES | | | | | | NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES |
|---|---|---|---|---|---|---|---|
| | Fruit Trees | Small Fruits* | Grapes | Vegetables | Ornamental | Lawns | |
| *Bacillus thuringiensis* | | | | X | X | | C.I.L. Organic Insect Killer |
| carbaryl 15 - 50% Spray | | X | | X | X | | C.I.L. Vegetable Insect Killer Sevin |
| | | X | | X | X | X | Co-op Liquid Sevin |
| | X | X | | X | X | | Co-op Sevin 50% W.P. Insecticide |
| | X | X | X | X | X | X | Green Cross Liquid Sevin Insecticide |
| | X | X | | X | X | X | Green Cross 50% Spray Powder Insecticide Sevin |
| | X | X | X | X | X | X | Sanex Liquid Sevin Insecticide |
| | X | X | X | X | X | X | Wilson Liquid Sevin Carbaryl Insecticide |
| carbaryl 2 - 5% Dust | X | X | | X | X | X | Wilson Sevin W.P. Garden Spray Insecticide |
| | | X | | X | X | | C.I.L. Vegetable Dust (Sevin) |
| | | X | X | X | | | Co-op Bug Killer Insecticide Dust |
| | | X | X | X | | | Green Cross King Bug Killer Insecticide Dust |
| | | | | X | | | Sanex Cabbage Dust Insecticide |
| | | | | X | | | Sanex 50% Sevin Dust Insecticide |
| | | X | X | X | X | X | Wilson Sevin Garden Dust Insecticide |
| carbaryl 5% Granular - Pellets | | X | | X | X | | Wilson Cutworm and Sowbug Bait Pellets |
| | | X | | X | X | | Wilson Earwig Destroyer |
| chlorpyrifos 5 - 10% Spray | | X | | X | X | X | C.I.L. Ant and Grub Killer E. C. (SOLGARD) |
| | | | | | X | X | C.I.L. Soil and Lawn Insect Killer E. C. |
| | | X | | X | X | X | Co-op Soil and Indoor Insecticide |
| | | X | | X | X | X | Green Cross Banisect |
| | | X | | X | X | X | Wilson Emulsifiable Lawn and Soil Insect Killer |
| chlorpyrifos 0.5% Granular | | | | X | X | X | Co-op Ant and Grub Killer |
| | | | | X | X | X | Co-op Cutworm Killer |
| chlorpyrifos 0.5% Dust | | | | X | X | X | C.I.L. Ant and Grub Killer Lawn and Soil Insecticide Dust Solgard |
| | | | | X | X | X | C.I.L. Earwig Killer Dust |
| | | | | X | X | X | C.I.L. Soil and Lawn Insect Killer Dust |
| | | | | X | X | X | Green Cross Ant and Grub Killer Insecticide Dust |
| | | | | X | X | X | Green Cross Banisect Home and Garden Insecticide |
| | | | | X | X | | Green Cross Cutworm Dust |
| | | | | X | X | X | Wilson Lawn and Soil Insect Killer Dust |

**Small fruits include raspberries, strawberries, currants, and gooseberries.*

## AVAILABLE INSECTICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

| COMMON CHEMICAL NAME AND CONCENTRATION OF ACTIVE INGREDIENT (TRADE NAMES IN BRACKETS) SPRAY, DUST GRANULAR ETC. | PERMITTED USES | | | | | | NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES |
|---|---|---|---|---|---|---|---|
| | Fruit Trees | Small Fruits* | Grapes | Vegetables | Ornamental | Lawns | |
| diazinon 6.5 - 12.5% Spray | X | X | X | X | X | X | C.I.L. Diazinon 12.5 Garden Spray Insecticide |
| | X | X | X | X | X | X | C.I.L. Fruit and Garden Insect Killer Diazinon |
| | X | X | X | X | X | X | Co-op Diazinon 12.5% E.C. Insecticide Liquid |
| | X | X | X | X | X | X | Green Cross Diazinon Garden and Fruit Tree Spray Liquid Insecticide |
| | X | X | X | X | X | X | Sanex Diazinon 12.5% E.C. Insecticide |
| | X | X | X | X | X | X | Wilson Liquid Diazinon Insect Spray |
| diazinon 5% Granular | | | | X | | X | C.I.L. Cutworm and Maggot Killer Diazinon |
| | | | | X | | | Co-op Garden Maggot Granules |
| | | | | X | | | Green Cross Maggot Killer Granular Insecticide |
| | | | | X | | X | Wilson's Granular Maggotox for Vegetables |
| dimethoate 23 - 24% Spray | X | X | | X | X | | C.I.L. Leafminer Killer Cygon 2-E |
| | X | X | | X | X | | Co-op Cygon 2-E Liquid Systemic |
| | X | X | | X | X | | Green Cross Cygon 240 E.C. Liquid Insecticide |
| | | X | | | X | | Sanex Cygon 2E Insecticide |
| | X | X | | X | X | | Wilson Cygon 2E Systemic Insecticide |
| dormant Oil Spray | X | X | | | X | | C.I.L. Dormant Oil E.C. |
| | X | | | | | | Co-op Dormant Oil Spray E.C. |
| | X | | | | X | | Green Cross Dormant Oil Spray |
| | X | | | | X | | Plant Products Dormant Oil Spray |
| | X | | | | X | | Sanex Dormant Oil E.C. |
| | X | | | | X | | Wilson Liquid Dormant Oil Spray |
| endosulfan 5% Spray | X | | | | X | | Wilson's Borer Kill Liquid Insecticide |
| insecticidal Soap | | | | X | X | | Safer's Aphid and Whitefly Killer |
| | X | X | | X | X | | Safer's Insecticidal Soap |
| | X | X | | X | | | Safer's Natural Insecticide for Fruits and Vegetables |
| | | | | | X | | Safer's Natural Insecticide for Rose and Flowers |
| | | | | | X | | Safer's Spider Mite Spray |
| lime sulfur 23 - 29% Spray | X | X | | | X | | Green Cross Liquid Lime Sulfur |
| | X | X | | | X | | Wilson Liquid Lime Sulfur |
| lindane 4.3% Spray | X | | | | X | | Green Cross Borer Spray |

**Small fruits include raspberries, strawberries, currants, and gooseberries.*

## AVAILABLE INSECTICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

| COMMON CHEMICAL NAME AND CONCENTRATION OF ACTIVE INGREDIENT (TRADE NAMES IN BRACKETS) SPRAY, DUST GRANULAR ETC. | PERMITTED USES | | | | | | NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES |
|---|---|---|---|---|---|---|---|
| | Fruit Trees | Small Fruits* | Grapes | Vegetables | Ornamental | Lawns | |
| malathion 12.5 - 50% Spray | X | | | X | X | | C.I.L. Malathion 50 |
| | X | | | X | X | | C.I.L. Ornamental Insect Killer Malathion |
| | X | | | X | X | | Co-op Malathion Liquid Insecticide |
| | X | X | | X | X | | Green Cross Malathion 50 E.C. Liquid Insecticide |
| | X | X | | X | X | | Sanex Malathion 50E |
| | X | X | | X | X | | Wilson 50% Malathion Liquid Insecticide/Miticide |
| metaldehyde 25% Spray | | | | X | X | X | Wilson Slug and Snail Killer and Barrier Spray |
| metaldehyde 2 - 2.75% Slug Bait Pellets | | | | X | X | | C.I.L. Slug Killer Pellets |
| | | | | X | X | | Co-op Slug Bait Insecticide Pellets |
| | | | | X | X | | Green Cross Slug Destroyer Pellets |
| | | | | X | X | | Plant Products Slug-Em Slug Bait |
| | | | | X | X | | Wilson's Slug Bait Pellets |
| methiocarb 2% | | | | | X | X | Green Cross Trump Slug Killer |
| methoxychlor 25% Spray | | | | | X | | Co-op Methoxychlor 25% Liquid Insecticide E.C. |
| | X | X | | X | X | | Sanex Moxy Garden Spray Concentrate |
| permethrin Spray | X | | X | X | X | | C.I.L. Garden Insect Killer (AMBUSH) |
| rotenone 0.7 - 1% | | | | X | | | C.I.L. Garden Insect Dust (ROTENONE) |
| | | | | X | X | | Co-op Garden Insect Dust |
| | | X | | X | | | Green Cross Deritox Garden Guard Organic Insecticide |
| | | X | X | X | X | | Wilson Organic Rotenone Insect Dust |
| rotenone 5% Spray | | X | X | X | X | | Wilson's Rotenone Spray Organic Insecticide W.P. |

## AVAILABLE FUNGICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| benomyl 50% Spray | | | | X | X | X | Plant Products Benomyl W.P. Systemic Fungicide |
| | X | X | X | X | X | X | Wilson's Benomyl Systemic Fungicide W.P. |
| captan 10% Spray | X | X | | X | X | | Green Cross Captan Fungicide 10% Wettable Powder |
| chlorothalonil 7.5 - 30% Spray | | | | | | X | C.I.L. Lawn Fungicide |
| | | | | X | X | | C.I.L. Rose and Garden Fungicide |
| lime sulfur 23 - 29% Spray | X | X | | | X | | Green Cross Liquid Lime Sulfur |
| | X | X | | | X | | Wilson Liquid Lime Sulfur |

*Small fruits include raspberries, strawberries, currants, and gooseberries.*

## AVAILABLE FUNGICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

| COMMON CHEMICAL NAME AND CONCENTRATION OF ACTIVE INGREDIENT (TRADE NAMES IN BRACKETS) SPRAY, DUST GRANULAR ETC. | PERMITTED USES | | | | | | NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES |
|---|---|---|---|---|---|---|---|
| | Fruit Trees | Small Fruits* | Grapes | Vegetables | Ornamental | Lawns | |
| maneb 80% Spray | | | | X | | X | Wilson Maneb Fungicide |
| oxine benzoate 2.5% | | | | X | X | | Plant Products No-Damp |
| sulfur 0.4% | | X | X | X | X | | Safer's Natural Garden Fungicide |
| sulfur 12.0% | | X | X | X | X | | Safer's Natural Garden Fungicide |
| sulfur 92% Spray or Dust | X | X | X | X | X | | Wilson Garden Sulfur Fungicide/Miticide |
| tribasic Copper Sulfate 53% | X | X | X | X | X | | Wilson Wettable Powder Fungicide Spray (BORDO) |

## AVAILABLE MULTIPURPOSE MIXTURES WITH DOMESTIC LABEL
(each containing several ingredients)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| captan + benomyl | X | X | | | X | | C.I.L. Fruit and Garden Fungicide Systemic |
| captan + carbaryl | | | | | X | | C.I.L. Soil and Bulb Dust Insecticide/Fungicide |
| captan + carbaryl + dicofol | X | | X | | X | | Co-op Fruit and Shrub Dust or Spray Insecticide/Fungicide |
| captan + methoxychlor + malathion | | | | X | X | | Co-op Flower and Garden Dust Insecticide/Fungicide |
| carbaryl + captan | | | | | X | | Wilson's Bulb and Soil Dust Insecticide/Fungicide |
| captan + chlorothalonil | | | | X | | | C.I.L. Insecticide/Fungicide for Vegetables (DEECOP) |
| carbaryl + copper | | | | X | | | Co-op Potato and Tomato Dust Insecticide/Fungicide |
| | | | | X | | | Green Cross Tomato and Potato Dust Insecticide/Fungicide |
| | | X | X | X | X | | Wilson Tomato and Vegetable Dust |
| carbaryl + dicofol + oxydemeton-methyl | | | | | X | | Wilson's Liquid Tree and Shrub Spray |
| carbaryl + malathion + captan | X | X | | X | X | | Green Cross Fruit Tree and Garden Spray or Dust |
| carbaryl + malathion + captan + sulfur | | | | | X | | Green Cross Rose Dust Insecticide/Fungicide |
| carbaryl + malathion + captan + thiophanate-methyl | | | | | X | | Green Cross (GARDAL) Rose and Evergreen Dust |
| carbaryl + zineb | | | | X | | | Green Cross King Products Potato Dust Insecticide/Fungicide |
| copper + carbaryl | | | | X | | | C.I.L. Insecticide/Fungicide Dust for Vegetables (DEECOP) |
| folpet + carbaryl + pirimicarb | | | | | X | | C.I.L. Insecticide/Fungicide for Roses and Flowers |
| folpet + malathion + carbaryl | | | | X | X | | C.I.L. Garden Dust Insecticide/Fungicide for Flowers and Vegetables |

**Small fruits include raspberries, strawberries, currants, and gooseberries.*

## AVAILABLE MULTIPURPOSE MIXTURES WITH DOMESTIC LABEL
(each containing one or more active ingredients)

| COMMON CHEMICAL NAME AND CONCENTRATION OF ACTIVE INGREDIENT (TRADE NAMES IN BRACKETS) SPRAY, DUST GRANULAR ETC. | PERMITTED USES | | | | | | NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES |
|---|---|---|---|---|---|---|---|
| | Fruit Trees | Small Fruits* | Grapes | Vegetables | Ornamental | Lawns | |
| folpet + malathion + carbaryl | | | | | X | | C.I.L. Rose Dust Insecticide/Fungicide |
| | | | | | X | | Wilson Rose and Flower Dust |
| malathion + dichlone + methoxychlor | X | | | | X | | Green Cross Guard'N Pride Liquid Fruit Tree Spray |
| methoxychlor + captan + sulfur + malathion | X | X | | X | X | | Co-op Rose Dust Insecticide/Fungicide |
| methoxychlor + malathion + captan + sulfur | | | | X | X | | Green Cross Multi-Purpose Flower and Vegetable Dust Insecticide/Fungicide |
| methoxychlor + malathion + dicofol | X | X | | X | X | | Wilson's Liquid Garden Spray All-Purpose Insecticide |
| phosalone + ferbam | X | | X | | | | Wilson Liquid Fruit Tree Spray |
| phosalone + ferbam | X | | X | | | | C.I.L. Insecticide/Fungicide for Fruit Trees |
| trichlorfon + oxydemeton-methyl | | | | | X | | C.I.L. Tree and Shrub Insect Killer (DUTOX®) |

## AVAILABLE RODENTICIDES WITH DOMESTIC LABEL
(containing one or more active ingredients)

| | | |
|---|---|---|
| brodifacoum 0.005% | See Labels for Areas of use | Wilson Wilsarin Rat and Mouse Killer Pellets |
| bromadiolone 0.005% | See Label for Areas of Use | Co-op Bromone Mouse Killer |
| | | Wilson Mouse Treat Bromone |
| | | Wilson Super Rat and Mouse Killer |
| chlorophacinone 0.005% | See Label for Areas of Use | Green Cross Mouse Bait Impregnated Canary Seed Bait |
| | | Wilson Bait Bloks Kills Rats and Mice |
| | | Wilson Mouse Treat |
| thiram 12% Liquid | See Label for Areas of Use | C.I.L. Rodent Repellent |
| | | Plant Products SKOOT Repellent for Rabbits, Mice and Deer |
| | | Wilson Rabbit Repell |
| warfarin concentrate 0.5% | See Label for Areas of Use | Wilson Warfarin Concentrate |
| warfarin pellets 0.025% | See Label for Areas of Use | Co-op Warfarin Rat Killer Rodenticide Pellets |
| | | Wilson Warfarin Rat and Mouse Killer Pellets Bacon and Cheese Flavored |
| warfarin meat/bait 0.025% | See Label for Areas of Use | Co-op Warfarin Rat Killer Rodenticide Meal |
| | | Green Cross Warfarin Rat Killer Bait |
| | | Wilson's Warfarin Rat and Mouse Killer Meal |
| warfarin + calciferol | See Label for Areas of Use | Green Cross Sorexa Super Mouse Bait |
| warfarin + sulfaquinoxaline | See Label for Areas of Use | C.I.L. Rat and Mouse Bait |

**Small fruits include raspberries, strawberries, currants, and gooseberries.*

*Pressurized sprays (aerosols) containing one or more of the above active ingredients are available. They are convenient for spot treatment of individual plants. For general use, they may be uneconomical and are generally less effective than conventional sprays. When using pressurized sprays always hold container at least one-half metre from the plants to avoid damage by the spray.*

Other pesticide products may be available which are not listed above. All manufacturers known to the editor were given the opportunity to supply information on their products; some did not respond.

# INSECTS AND INJURY

Actual size of full-grown insect
shown as

Figure 1 — Aphid
Refer to pages 11, 31, 33, 36, 51

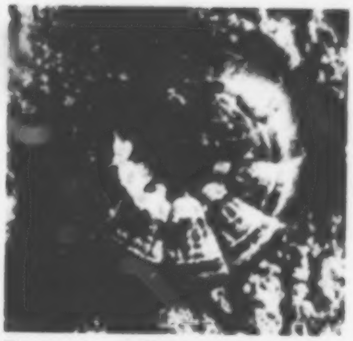

Figure 2 — Cutworm in curled position
Refer to pages 11, 55

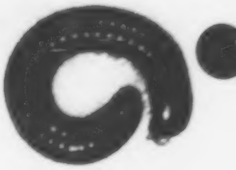

Figure 3 — Millipede
Refer to pages 13, 57

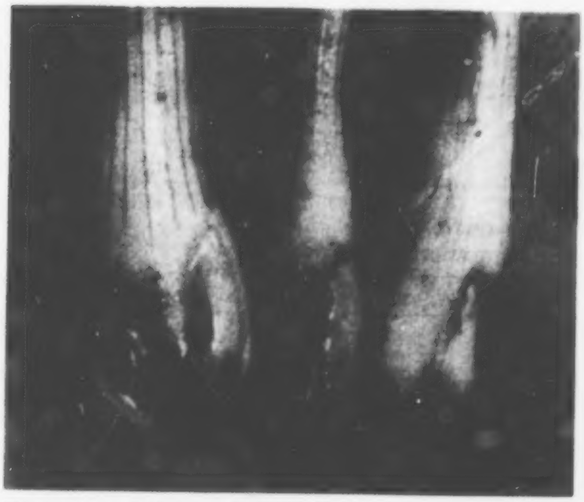

Figure 4 — Onion maggot and injury
Refer to page 18

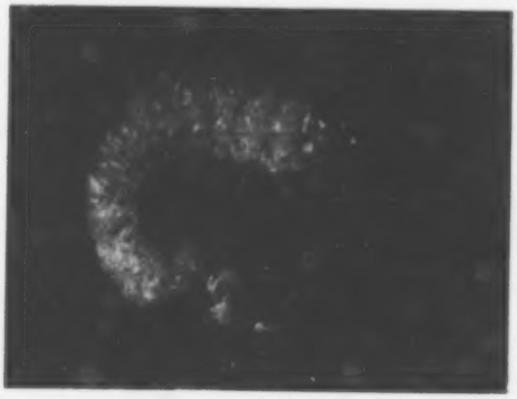

Figure 5 — White grub
Refer to pages 13, 38, 58, 60, 70

Figure 6 — Collar for root maggots
Refer to page 16

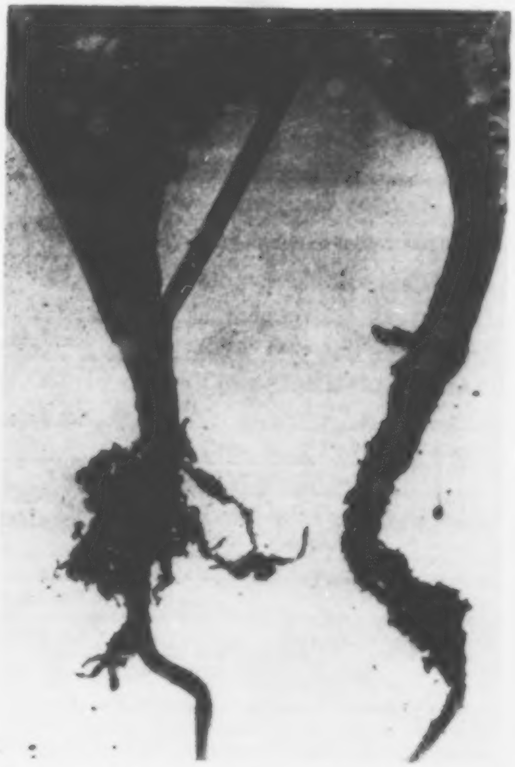

Figure 7 — Root maggot and injury on cabbage plants
Refer to page 16

# INSECTS AND INJURY

Actual size of full-grown insect shown as

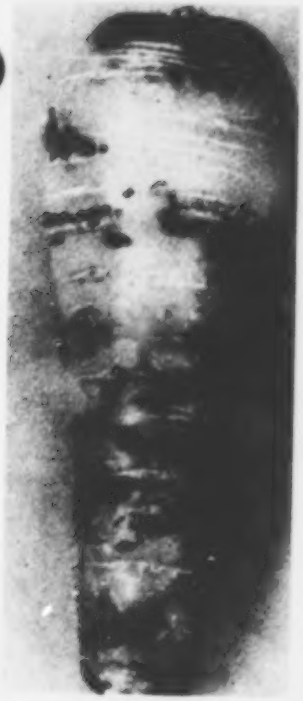

Figure 8 — Injury by carrot rust fly maggot
Refer to page 17

Figure 9 — Seed corn maggot injury (healthy plant on left)
Refer to pages 15, 18

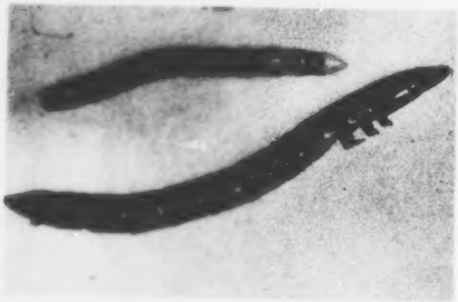

Figure 10 — Wireworms
Refer to pages 13, 38, 60

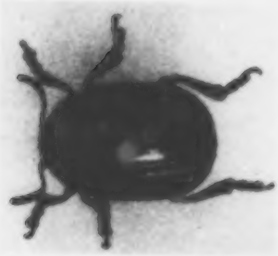

Figure 11 — Colorado potato beetle
Refer to page 19

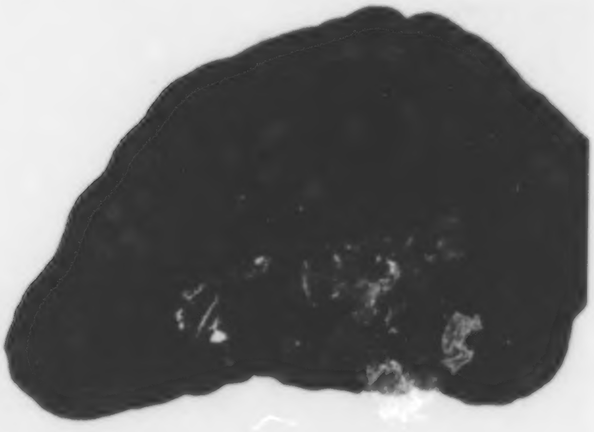

Figure 12 — Leafminer injury on spinach
Refer to page 15

Figure 13 — European corn borer injury
Refer to page 20

# INSECTS AND INJURY

Actual size of full-grown insect shown as ⊢——⊣

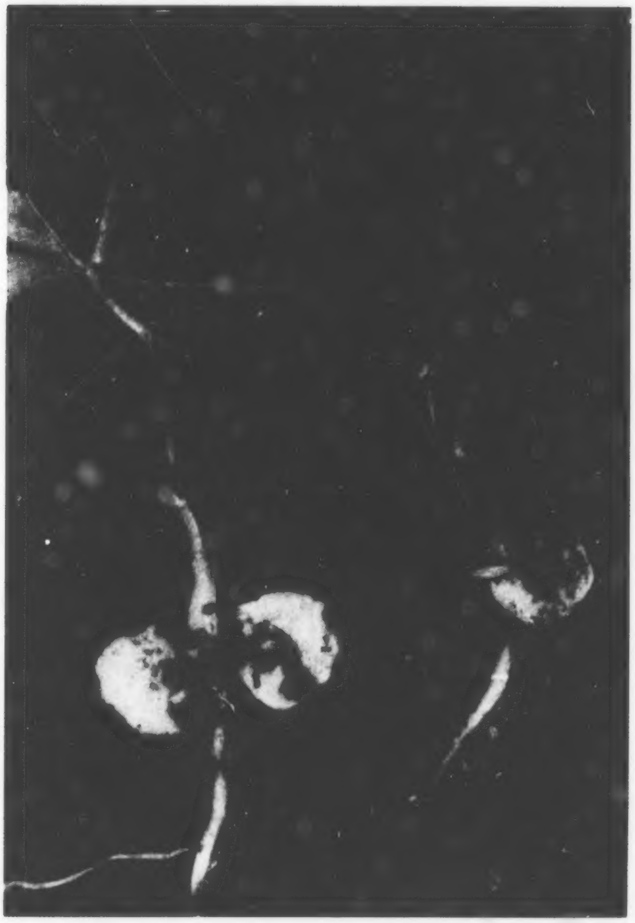

Figure 14 — Seed corn maggot and injury on peas
Refer to pages 15, 18, 22

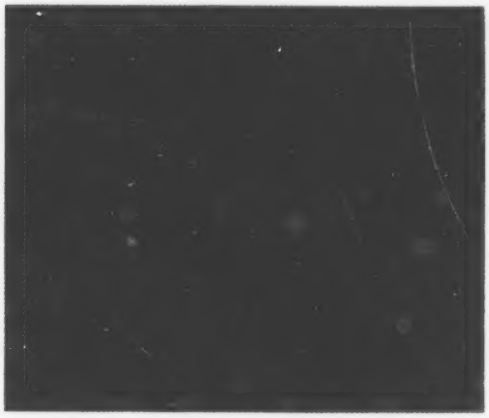

Figure 15 — Curculio injury on apple
Refer to page 28

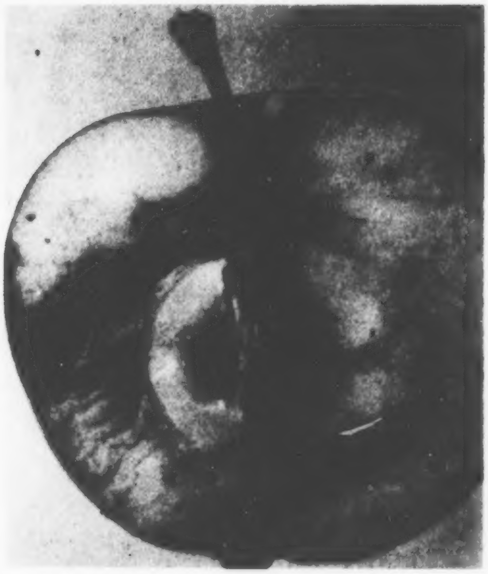

Figure 16 — Codling moth larva in apple
Actual size of full-grown insect shown as

⊢——⊣

Refer to page 29

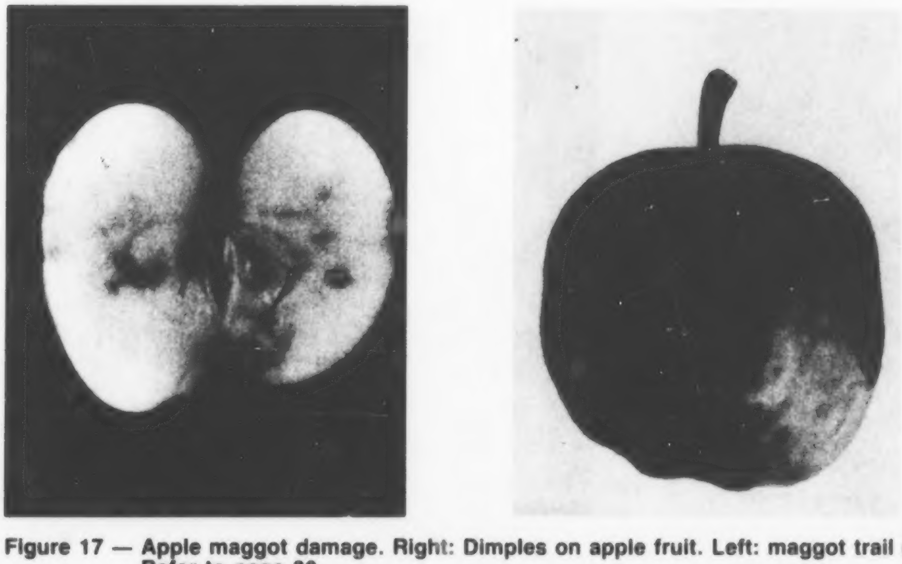

Figure 17 — Apple maggot damage. Right: Dimples on apple fruit. Left: maggot trail deep in flesh.
Refer to page 30

# INSECTS AND INJURY

Actual size of full grown insect shown as ├──────┤

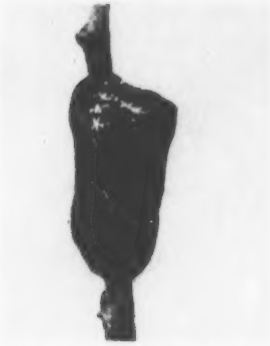

Figure 18 — Egg mass of tent caterpillar
Refer to pages 28, 53

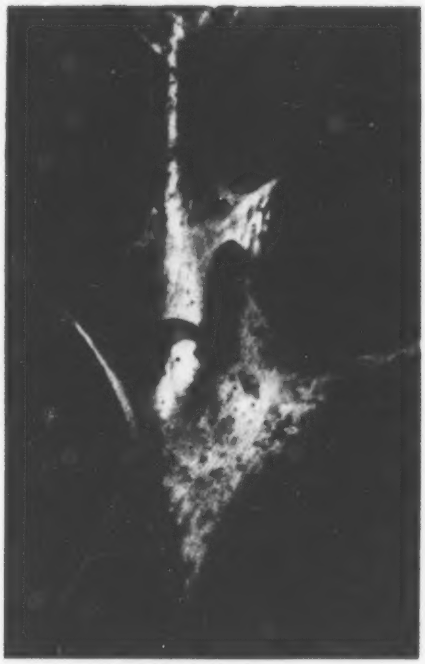

Figure 19 — Tent caterpillar on tent
Refer to pages 28, 53

├──────┤

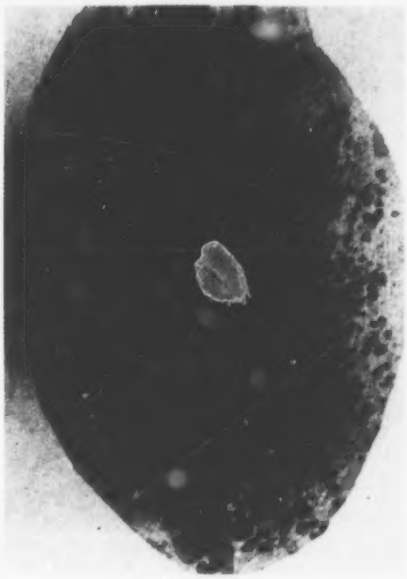

Figure 20 — Pear leaf blister mite injury on apple
Refer to page 31

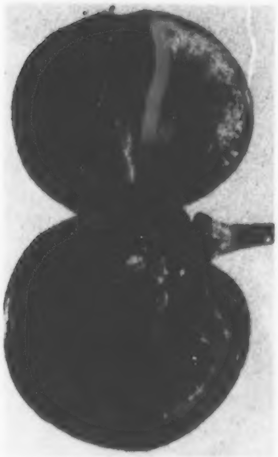

Figure 21 — Cherry maggot and injury
Refer to page 33

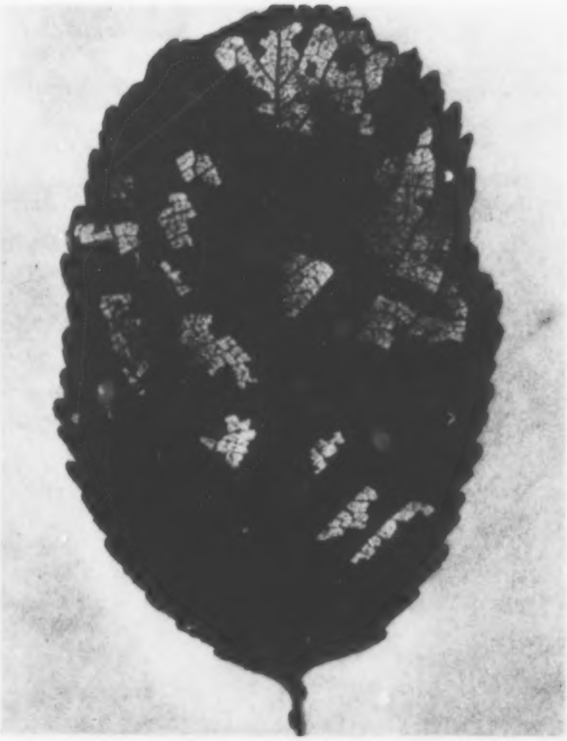

Figure 23 — Pear slug larvae on Prunus leaf; note skeletonization injury
Refer to pages 31, 57

# INSECTS AND INJURY

Actual size of full-grown insect shown as ├──────┤

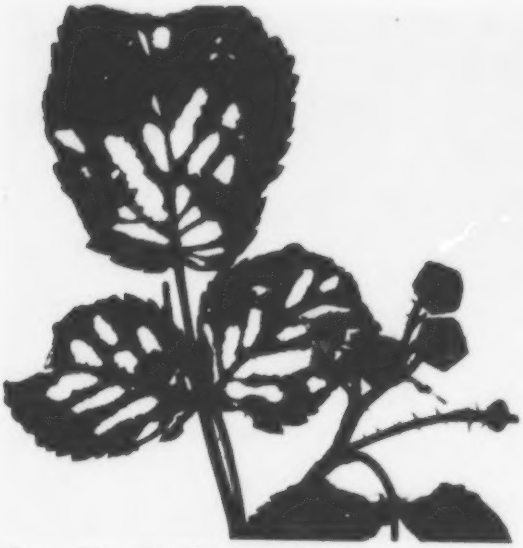

Figure 24 — Raspberry sawfly injury
Refer to page 37

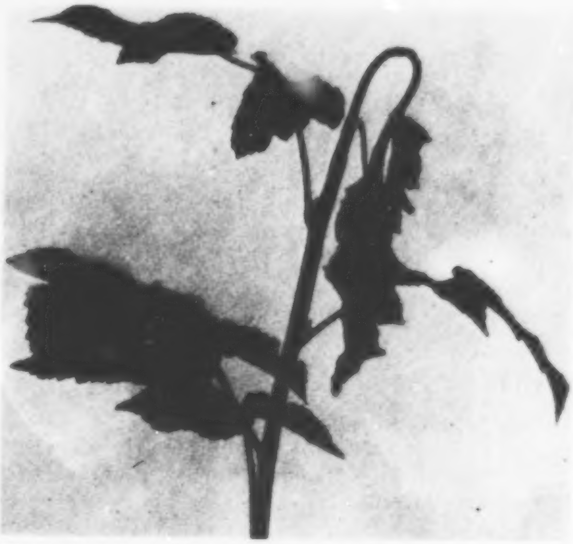

Figure 25 — Raspberry cane borer injury
Refer to page 36

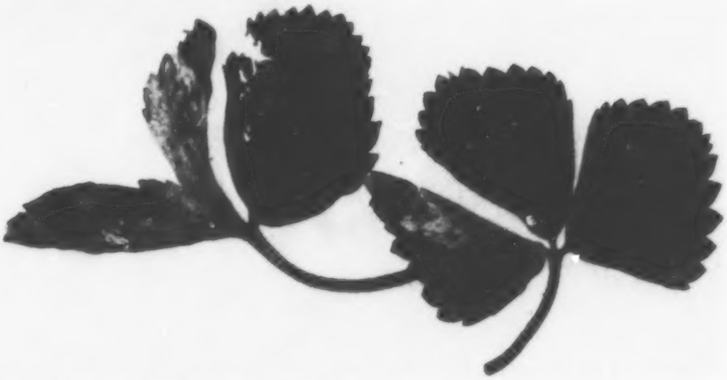

Figure 26 — Strawberry leafroller injury
Refer to page 38

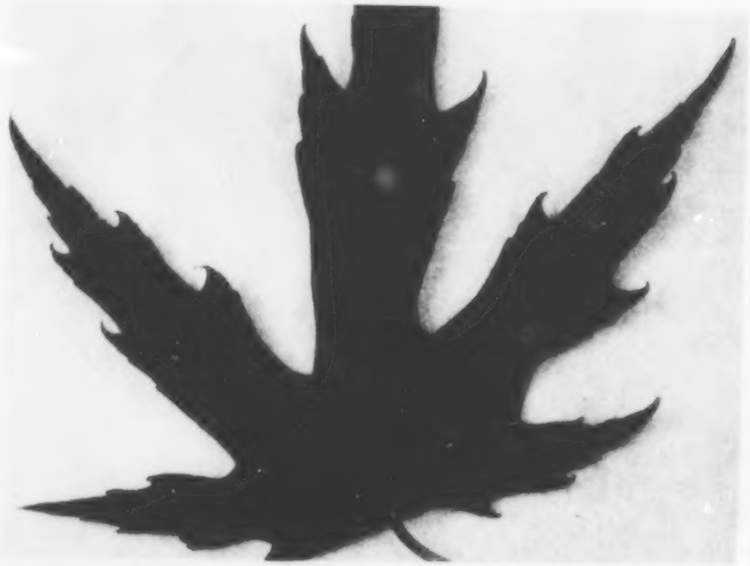

Figure 27 — Maple bladdergall mite galls on silver maple
Refer to page 55

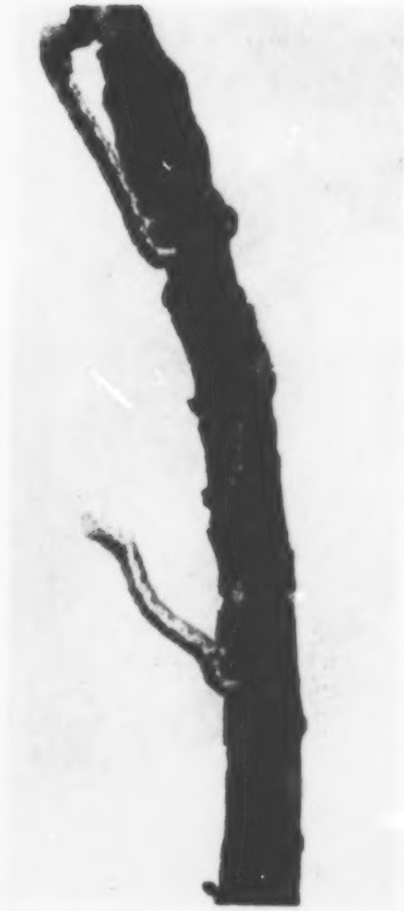

Figure 28 — Cankerworms (actually a looper) ├──────┤
Refer to page 53

# INSECTS AND INJURY

Actual size of full-grown insect shown as ├───────────┤

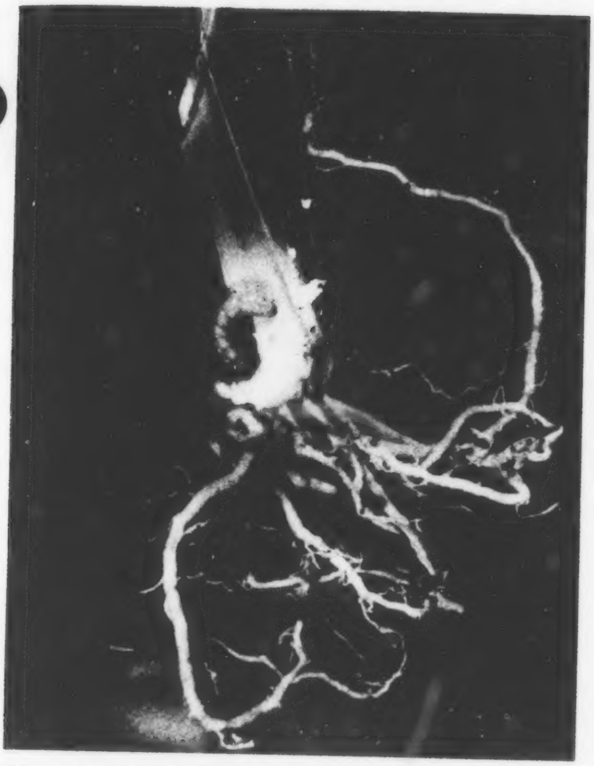

Figure 29 — Iris borer
Refer to page 56

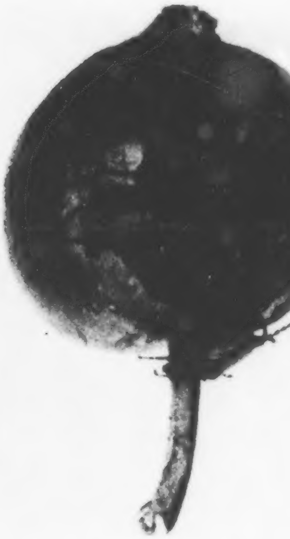

Figure 30 — Rose chafers (adult beetles)
Refer to page 58

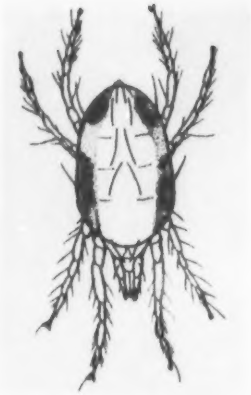

Figure 31 — Spider Mite (microscopic)
Refer to pages 28, 57

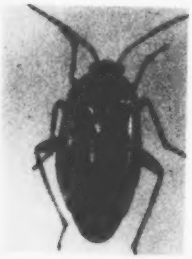

Figure 32 — (a) Tarnished plant bug adult ├──┤
Refer to pages 29, 38, 58

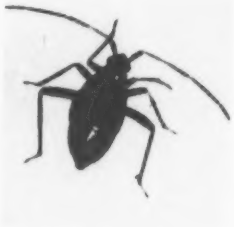

Figure 32 — (b) Nymph (young plant bug)

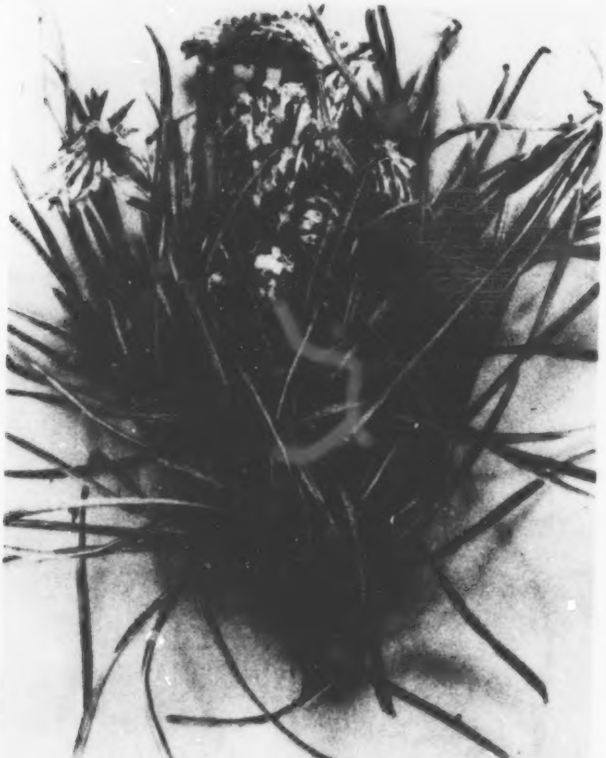

Figure 33 — Pine shoot moth injury
Refer to page 58

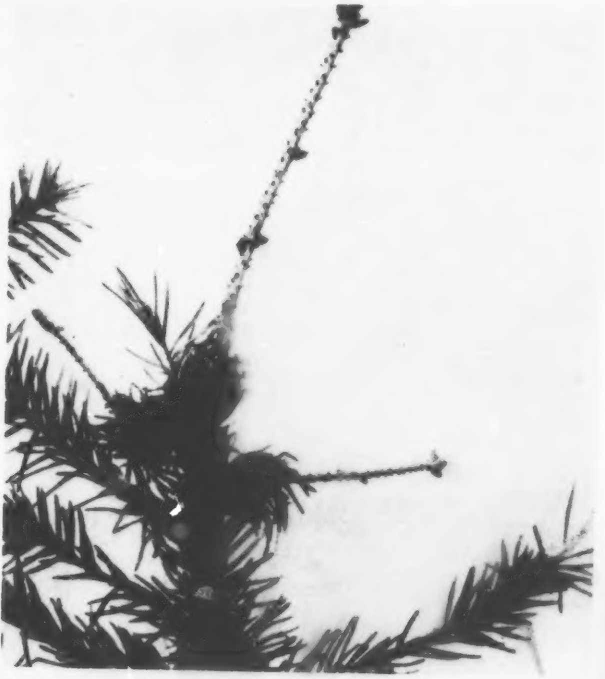

Figure 34 — Spruce gall aphid injury
Refer to page 56

# INSECTS AND INJURY

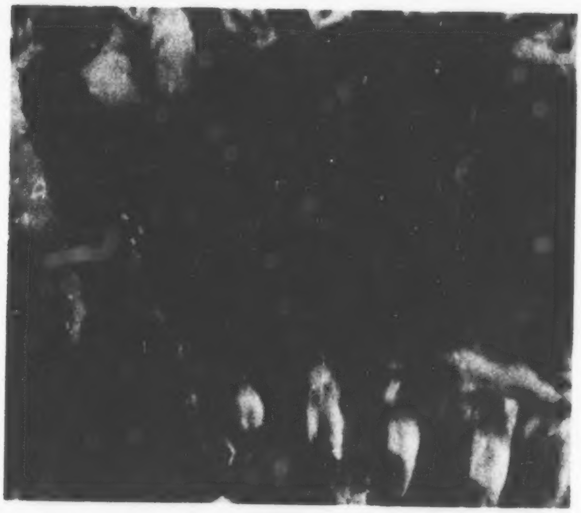

Figure 35 — Left: European corn borer larva; Right: Corn earworm larva; Refer to pages 20, 21

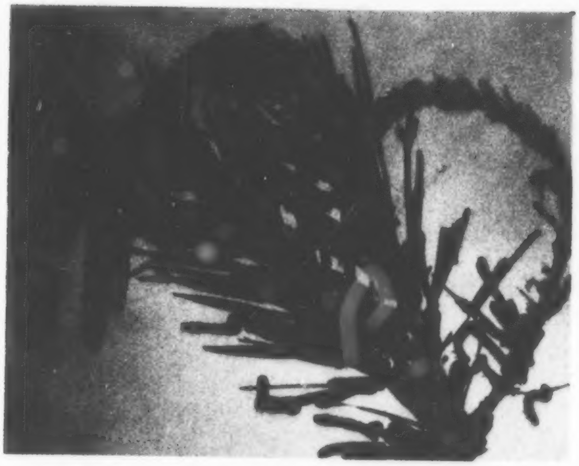

Figure 36 — European pine saw fly caterpillars on pine
Refer to page 54

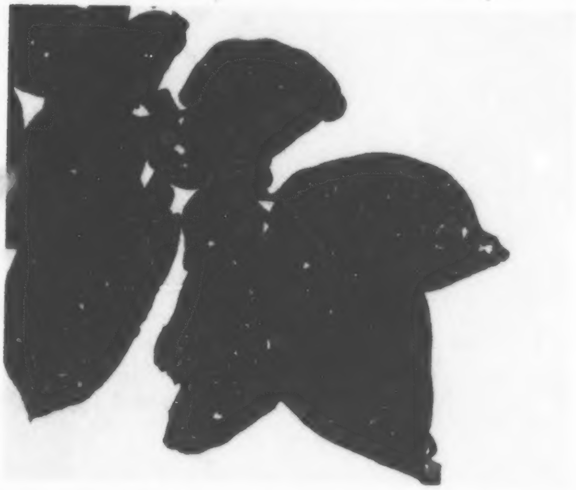

Figure 37 — Flea beetle injury on potato leaves; note shot-holes in leaf
Refer to page 12

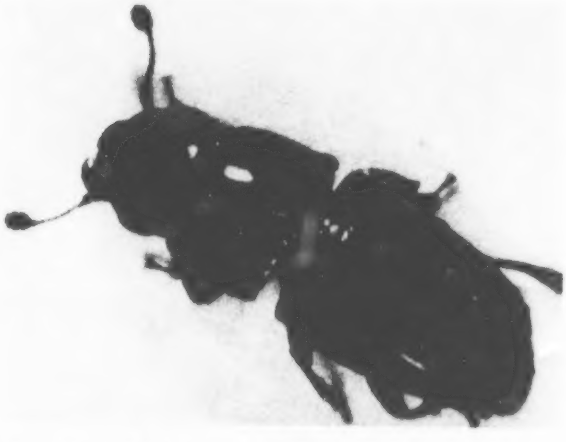

Figure 38 — Sap beetle adult
Refer to pages 21, 23, 37

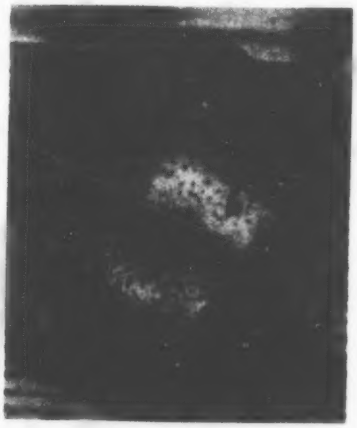

Figure 39 — Plant bug injury to pear
Refer to page 29

Figure 40 — Cottony maple scale, adults and tiny crawlers (actual size)
Refer to page 59

# DISEASE SYMPTOMS AND OTHER INJURIES

**Figure 41** — Early blight on potato leaf
Refer to page 20

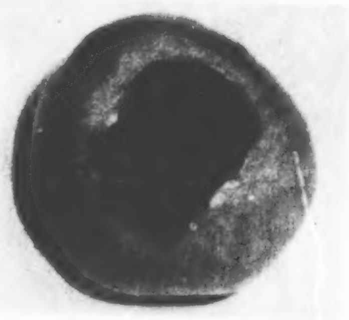

**Figure 42** — Blossom-end rot on tomato
Refer to page 23

**Figure 43** — Septoria leaf spot on tomato leaflet
Refer to page 23

**Figure 44** — Late blight on potato leaf
Refer to page 19

**Figure 45** — Late blight injury on potato tubers
Refer to page 19

**Figure 46** — Apple scab on leaf
Refer to pages 30, 67

# DISEASE SYMPTOMS AND OTHER INJURIES

Figure 47 — Clubroot damage on cabbage
Refer to page 17

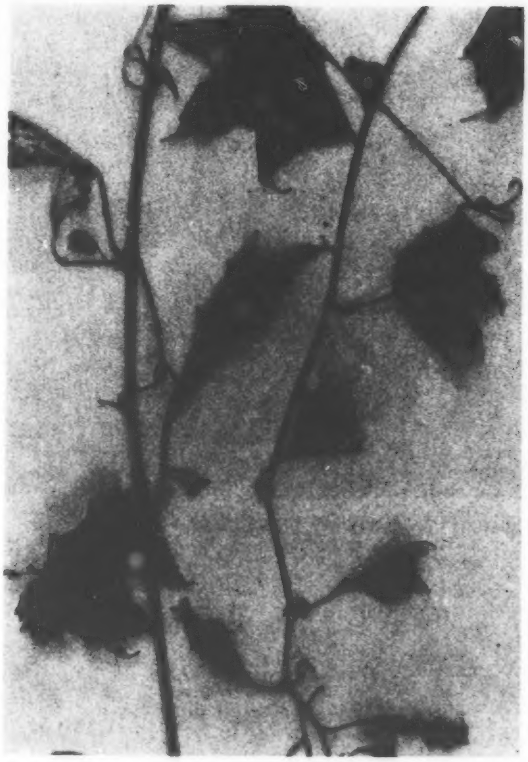

Figure 48 — Lawn weed killer injury to grape foliage
Refer to pages 13, 49

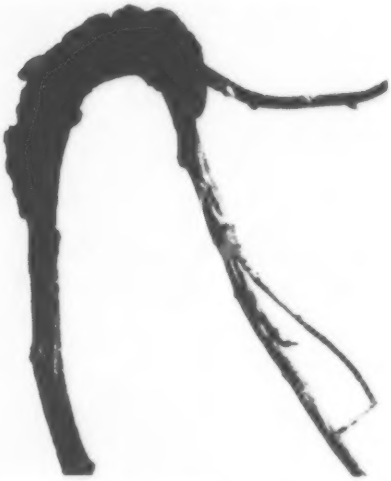

Figure 49 — Black knot on plum
Refer to page 33

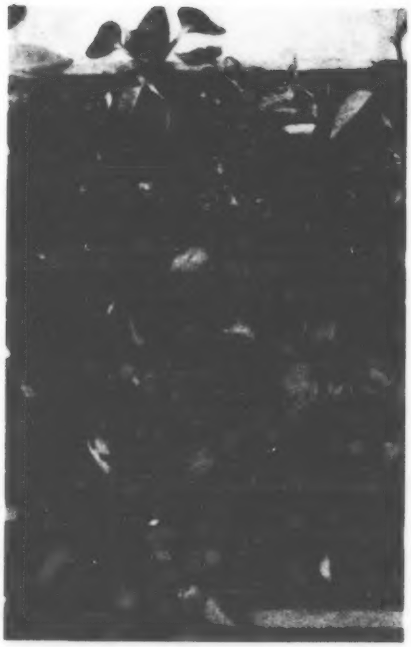

Figure 51(a) — Damping-off in seedlings
Refer to pages 12, 63

Figure 51(b) — Damping-off
Notice the constriction
at the stem base.

Figure 50 — Apple scab on fruit
Refer to pages 30, 67

# DISEASE SYMPTOMS AND OTHER INJURIES

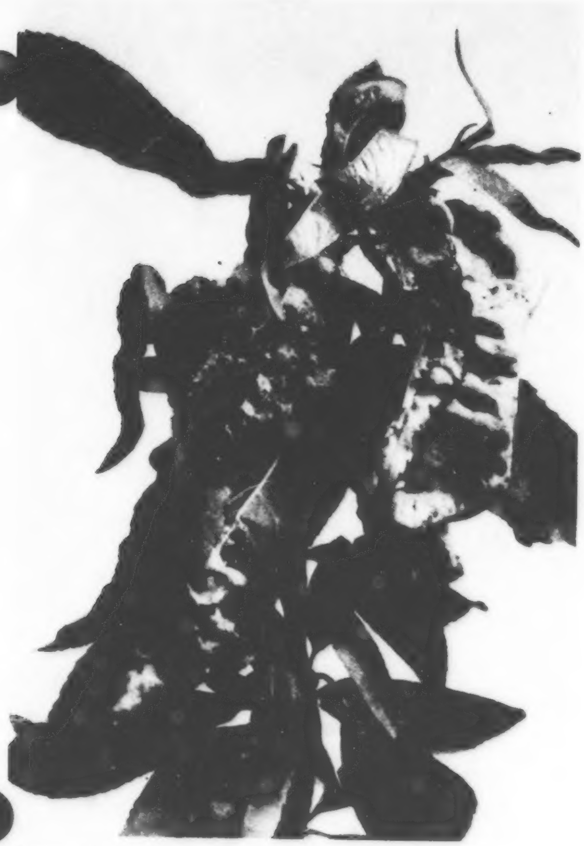

**Figure 52** — Leaf curl on peach
Refer to page 32

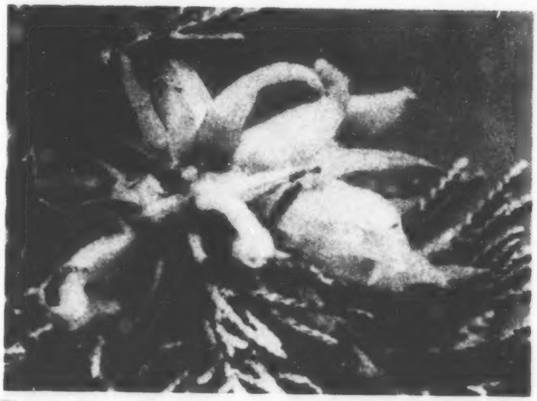

**Figure 53** — Gelatinous horns protruding from cedar-apple rust gall on juniper
Refer to page 63

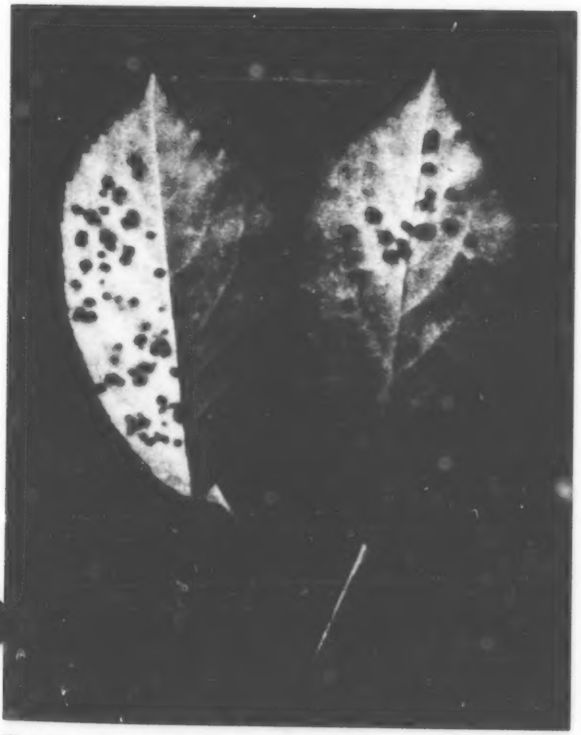

**Figure 54** — Leaf spot on cherry
Refer to page 33

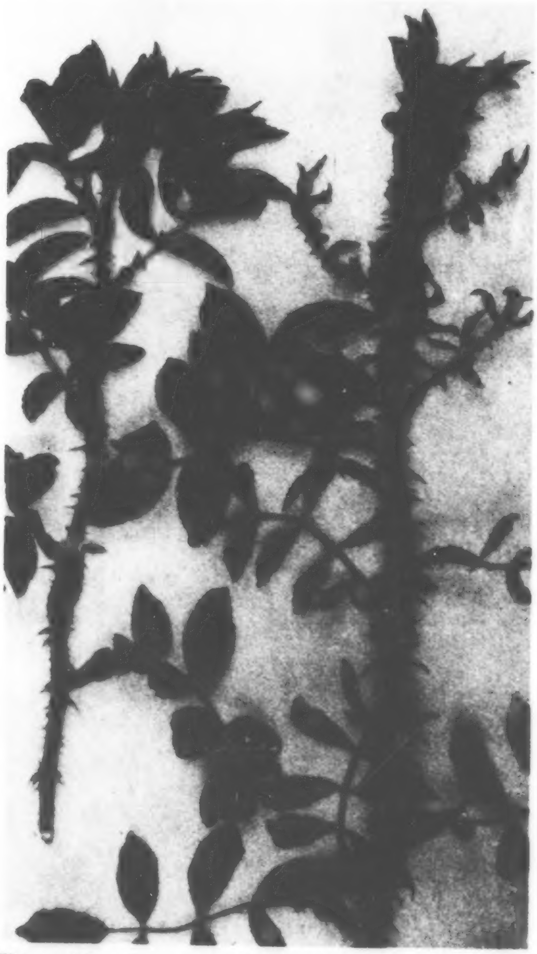

**Figure 55** — Lawn weed killer injury to rose; healthy foliage is on left.
Refer to page 49

# DISEASE SYMPTOMS AND OTHER INJURIES

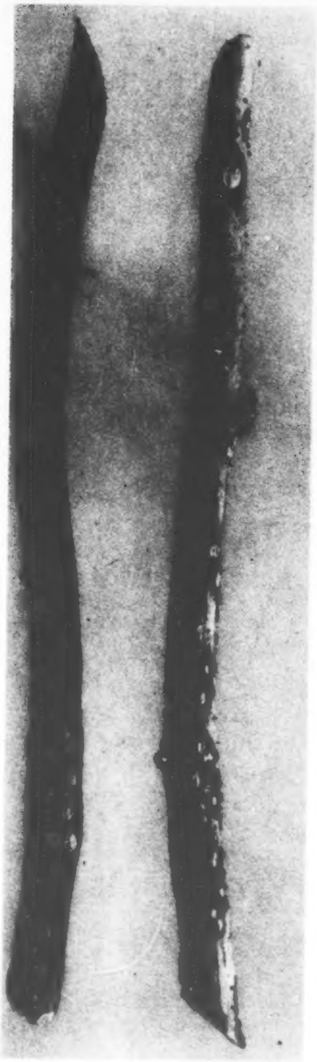

Figure 56 — Anthracnose on raspberry canes Refer to page 35

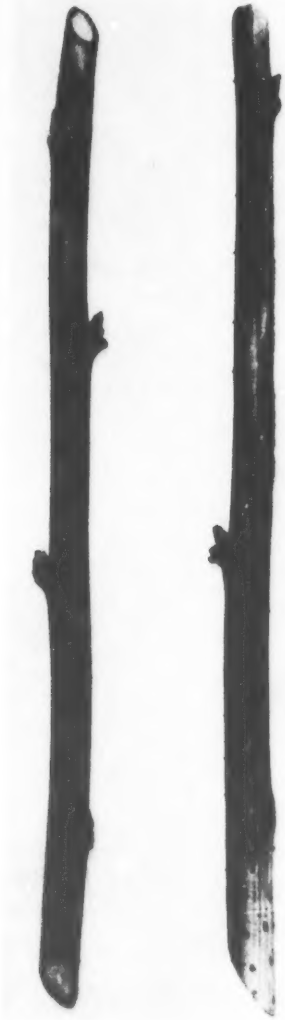

Figure 57 — Spur blight on raspberry canes Refer to page 35

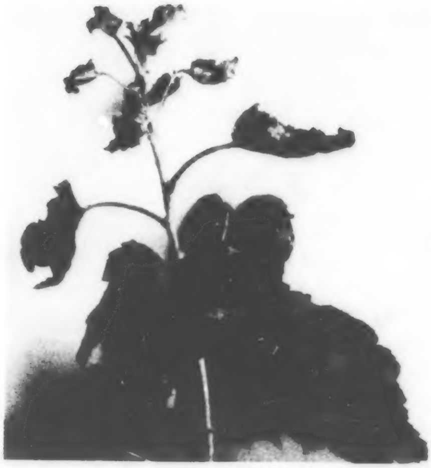

Figure 58 — Powdery mildew on gooseberry Refer to page 34

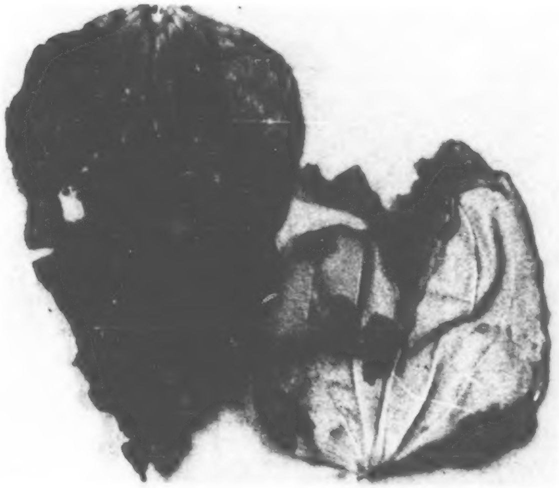

Figure 59 — Leaf spot on zinnia leaves Refer to page 65

# DISEASE SYMPTOMS AND OTHER INJURIES

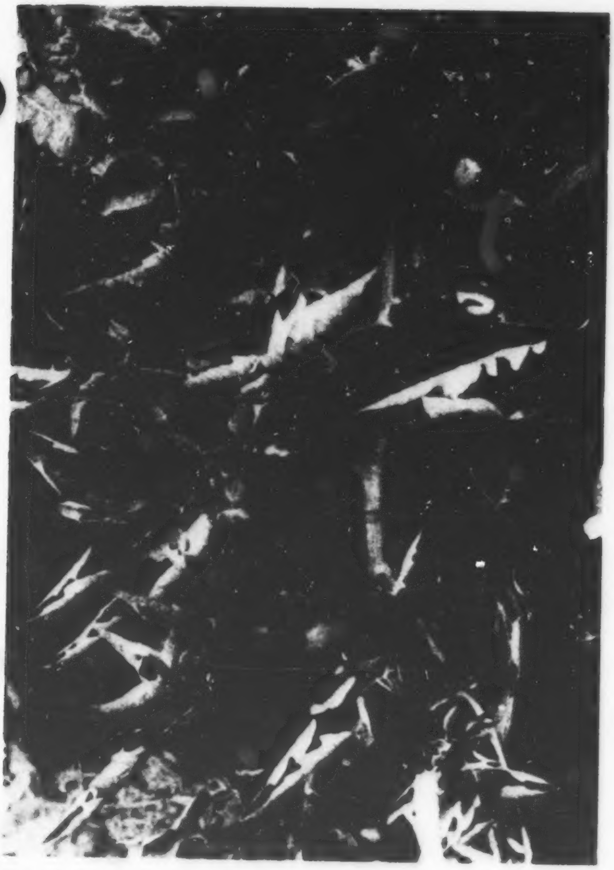

Figure 60 — Leafroll on tomato
Refer to page 23

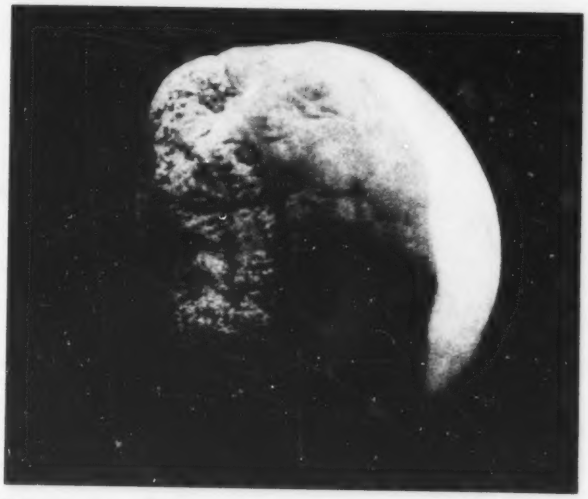

Figure 61 — Brown rot on peach
Refer to page 33

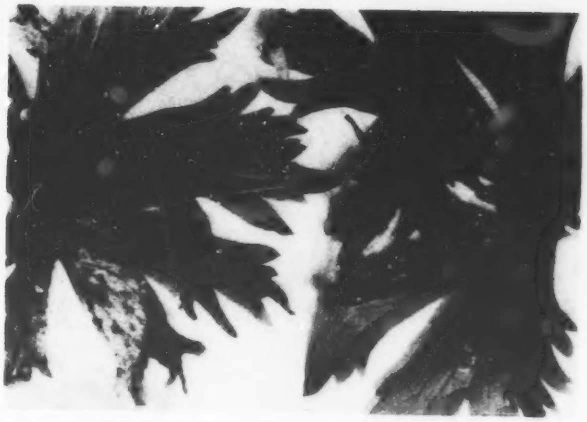

Figure 62 — Leaf spot on delphinium
Refer to page 65

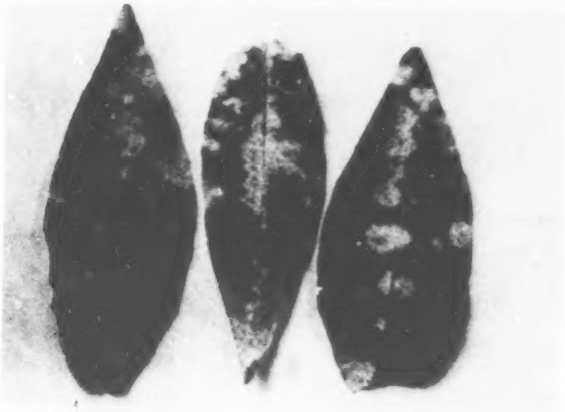

Figure 63 — Powdery mildew
Refer to pages 35, 66

# DISEASE SYMPTOMS AND OTHER INJURIES

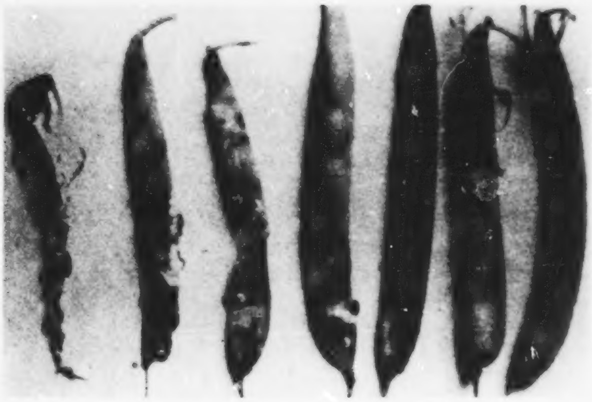

Figure 64 — White mold on beans; healthy pods are on right.
Refer to pages 15, 67

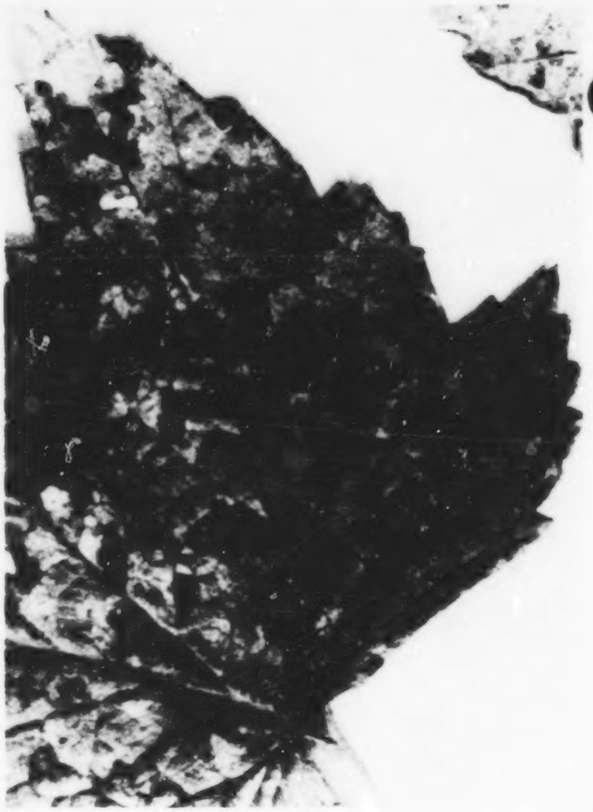

Figure 65 — Rust on currant
Refer to pages 34, 66

Figure 66 — Anthracnose of sycamore
Refer to page 64

Figure 67 — Mosaic virus on
bean leaf
Refer to page 14

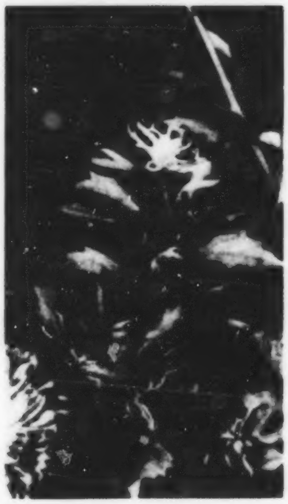

Figure 68 — Asteryellows
on china aster; note
malformation of flowers
Refer to page 61

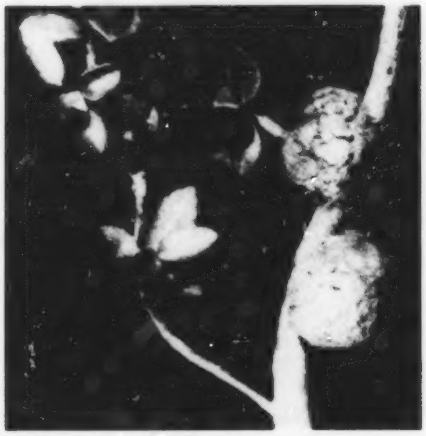

Figure 69 — Grown galls on Euonymus
Refer to pages 27, 63

# THE METRIC SYSTEM

**Linear Measures (length)**

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

**Square Measures (area)**

100 m × 100 m = 10,000 $m^2$ = 1 hectare (ha)
100 ha = 1 square kilometre ($km^2$)

**Cubic Measures (volume)**

*Dry Measure*

1000 cubic millimetres ($mm^3$) = 1 cubic centimetre ($cm^3$)
1,000,000 cubic $cm^3$ = 1 cubic metre ($m^3$)

*Liquid Measure*

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

**Weight Measures**

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

**Weight - Volume Equivalents**

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

*Dry-Liquid Equivalents*

1 $cm^3$ = 1 mL
1 $m^3$ = 1000 L

## HOW TO USE METRIC MEASUREMENTS

Since January 1, 1981 all pesticide labels give directions in metric measurements only. The easiest way to change over to this new system is to make *your* measurements also in metric. This may seem difficult but it is really quite simple as long as you have the proper tools for it. You thus avoid having to calculate the conversions from Imperial to metric measurements.

**Measuring the surface area and length of row:** For treatment of lawns and for soil insects in vegetables and flowers you have to know the surface area in square metres, whereas you need the length of row in metres when treating row crops, such as onions, with a maggot killer. Take a long stick or slat and cut it to the length of either one, two or three metres (1 metre = 40 inches), depending on the size of your garden and your own preference. Now you have a handy measuring stick and you should forget about "yards" and "feet".

**Measuring the volume of water:** The second tool you need is a plastic pail for preparing spray mixtures. At the levels of one, two, three, four, five, six and seven litres (1 litre = 35 fluid ounces) make marks on the inside of the pail with paint or a waterproof felt market. To avoid other uses mark this pail on the outside with the word "insecticides, fungicides only".

**Measuring liquid insecticides and fungicides:** You also need a tool for measuring liquid pesticides from the bottle or can. The common tablespoon holds 15 millilitres and the teaspoon holds 5 mL. These well-known spoon measures can still be used for the metric system. Many product labels also give the rate in spoonfuls.

**Measuring dry pesticides:** Many manufacturers state the recommended rate for wettable powders and granular products by volume instead of by weight. Hence the tablespoon (= 15 mL) and the teaspoon (= 5 mL) can be used. Keep in mind that "level" spoonfuls and not heaped spoonfuls should be used. If some product labels give the rate by weight in grams, you can also use spoon measures because the level tablespoon equals about 15 grams and the level teaspoonful equals about 5 grams.

## METRIC CONVERSIONS

5 mL = 1 tsp.
15 mL = 1 tbsp.
28.5 mL = 1 fl. oz.

**YIELD**

**TO**
**INSTRUCTIONS**
**ON THE**
**LABEL**

RV-1-90-45M
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ISSN 0713-1313